SCIENTIFIC STUDIES 2022

ELECTROMAGNETIC FIELDS AS A HEALTH RISK FACTOR

Jakusova V, Sladicekova KH. Electromagnetic fields as a health risk factor. Clin Soc Work Health Interv 2022; 13 (6): 49-57. doi: 10.22359/cswhi_13_6_10

Abstract

This study is a collection of findings of published articles from the Department of Medical Biophysics and Department of Pub- lic Health at the Jessenius Faculty of Medicine in Martin, Comenius University Bratislava (JFM CU) with the topic on epidemiology of electromagnetic fields. During 14 years, 13 principal publications were created, of which 11 studies deal with radio frequency signals from mobile phones (mainly GSM900 and GSM1800 standard); one study describes the construction of a new exposure system and the other deals with the effects of low frequency electromagnetic fields. The results showed that the electromagnetic fields can affect heart rate variability both in humans and animals; increasing the activity of the parasympathetic or sympathetic nerve systems depending on place of body exposure (head or thorax, respectively); may cause disorders of heart rhythm; loss of concentration; headaches; and/or burning sensations in the ear area.

Parameters of exposition were compared with the values issued by the International Commission on Non- Ionizing Radiation Protection (ICNIRP). They had not exceeded the permitted limits. However, compared to data of the BioInitiative Report, in some cases, our measured values exceeded their limits.

Open access paper:
https://clinicalsocialwork.eu/wpcontent/uploads/2022/11/cswhi_06_2022_10_jakusova.pdf

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RADIATION EFFECT ANALYSIS ON HUMAN HEAD CAUSED BY DIFFERENT FREQUENCIES OF MOBILE PHONE ANTENNA

Zhang X, Zhou W. 2022 International Applied Computational Electromagnetics Society Symposium (ACES-China), Xuzhou, China, 2022, pp. 1-3, doi: 10.1109/ACES-China56081.2022.10065276.

Abstract

This article discusses the bio-electromagnetic effects of the human head who exposure to the different operation frequency of three kinds of mobile phones. Three kinds of exposure sources with microwave and millimeter-wave bands respectively, which include the dual-band PIFA antenna operating at 900 MHz and 1860 MHz, the patch antenna operating at 3.5 GHz and the dual-band millimeter-wave antenna operating at 27 GHz and 40 GHz. We take a three-layer ball head model as the human head, and use the COMSOL Multiphysics software to simulate the specific absorption rate (SAR) and the absorbed power density (Sab) and temperature rise performance in the human head. The maximum SAR in human head is 1.41 W/kg and 4.4 W/kg, when it exposed to the microwave antenna and millimeter-wave antenna respectively. The results show that the millimeter-wave antennas have higher radiation energy than the microwave antennas for the human head model. The radiation dose absorbed in the human tissues are all below the limit restriction.
https://doi.org/10.1109/ACES-China56081.2022.10065276

EVALUATION OF COGNITIVE FUNCTIONS AND EEG RECORDS IN RATS EXPOSED TO 2.45 GHZ ELECTROMAGNETIC FIELD

Yucel H, Dundar NO, Doguc DK, Uguz C, Celik O, Aksoy FT, Nazıroglu M, Comlekci S, Dundar B. Evaluation of cognitive functions and EEG records in rats exposed to 2.45 GHz electromagnetic field. Int J Radiat Res 2022, 20(4): 753-760.

Abstract

Background: Electromagnetic fields may primarily affect cognitive functions. It has not been elucidated how electromagnetic radiation affects the brain, particularly in the young age group. We aimed to examine the cognitive function, expression of N-methyl-D-aspartate receptors (NMDA), and EEG alterations in weaned rats exposed to a 2.45 GHz electromagnetic field.

Materials and Methods: Twenty-one weaned (21 days old) male Wistar Albino rats were divided into two groups as experimental group (n=12) and control group (n=9). Animals in the experimental group were exposed to a 2.45 GHz electromagnetic field for one hour a day for more than 28 days. At the end of this period, rats were subjected to training and learning test using Morris Water Maze. After obtaining EEG records, hippocampi were removed. 2A and 2B subunits of NMDA receptors were studied in hippocampal homogenates using the Western Blot method.

Results: There were no statistically significant differences between the two groups in measures of latency to target quadrant, time spent in the target quadrant, and average swim speed as compared in Morris water maze. However, the time to arrive at the visible platform was significantly longer in experimental animals. There were no statistically significant differences in expression of 2A and 2B subunits of NMDA receptors between the two groups. Evaluation of EEG records revealed that spike frequency was significantly higher and time to first spike was significantly shorter in the experimental group.

Conclusion: These results indicated that a 2.45 GHz electromagnetic field might negatively affect EEG, motivation, and attention, particularly in the young age group.

Open access paper: http://ijrr.com/article-1-4460-en.pdf

NON-IONIZING RADIATION AS POSSIBLE CARCINOGEN (REVIEW)

Gupta S, Sharma RS, Singh R. Non-ionizing radiation as possible carcinogen. Int J Environ Health Res. 2022;32(4):916-940. doi:10.1080/09603123.2020.1806212.

Abstract

The advent of wireless technologies has revolutionized the way we communicate. The steady upsurge in the use of mobile phone all over the world in the last two decades, while triggered economic growth, has caused substantial damage to the environment, both directly and indirectly. The electromagnetic radiation generated from mobile phones, radio-based stations, and phone towers, high-voltage power lines have been reported which leads to the variety of health scares such as the risk of cancer in human beings and adverse effects in animals, birds, etc. Though the usage of such radiation emitting from mobile phones has risen steeply, there is a lack of proper knowledge about the associated risks. The review provides the latest research evidence based both on in vitro studies, in vivo studies, and possible gaps

in our knowledge. Moreover, the present review also summarizes available literature in this subject, reports and studies which will help to form guidelines for its exposure limits to the public. https://pubmed.ncbi.nlm.nih.gov/32885667/

Conclusion

In conclusion, the results of the investigations were inconclusive, and in fact, indicated little or no association between the exposure to RFR with that of radiation and cancer. But NTP reported that RFR causes cancer in experimental animals. Nevertheless, it should also be pointed out in several epidemiological studies where weak association between carcinogenicity and RFR was observed. All the more reasons that the effects and the risk associated with the exposure to mobile phones were not consistent and didn't show any regular pattern. Studies on the exposure in children were also very limited. This discussion was intended to answer whether there's a health risk involved with the use of mobile phones, but at this stage, the review has not all the answers. The good thing is, several researchers are working on this field, and with more studies we'll surely get better clarity on the subject. Although there's little doubt of the risks involved with mobile phone usage, and therefore, this review indicates that precautions are needed while using mobile phones. Although the available evidences do not provide a link between the exposure to RFR and microwave radiation and its effect on human health, at this moment, it's not possible to state otherwise as well. In the case of cancer, only the studies that were conducted for more extended period of time able to indicate any association between the use of mobile phone and cancer, especially brain cancer. The above studies suggested that GSM operated mobile phones have significant effect in comparison to CDMA operated mobile phones. As mobile phones have become an integral part of our everyday life, and so, it's even more critical today to study their effects on the human body. To conclude, it's time for government agencies and concerned bodies to understand the potentially harmful effects of RFR and to consider preventive actions like use of good phone brands keeping health and safety at priorities, use of Bluetooth (hands-free devices) and mobile phones having minimum SAR value. Animal studies for longer period of time are needed to execute for the probable health effects. There are no useful data available regarding RF; thus only data suggest a health risk associated with RF so far and the research is still shapeless, about both the amount and quality of available data. Thus, it's not possible to draw any conclusions yet and we must wait for future results.

EFFECT OF MOBILE PHONE RADIATION ON PAROTID AND SUBMANDIBULAR SALIVARY GLANDS-AN ULTRASONOGRAPHIC STUDY

Yendluru, MS. Rana P, Sekhar MC, Chakravarthi GD, Suresh D, Nagajyoki P, Meghana G, Solanke S. Effect of Mobile Phone Radiation on Parotid and Submandibular Salivary Glands-An Ultrasonographic Study. J Clinical Diagnostic Research. Oct 2022. 16 (10) , pp.ZC25-ZC30.

Abstract

Introduction: In this era of digitalism, mobile phones have become a cultural accessory. Frequent smartphone usage results in possible adverse effects from low radiofrequency radiation and thermal effect emitted by these devices. One of the major concerns is salivary glands as the mobile phones are held against the side of face in close proximity to these glands.

Aim: To assess the effect of cell phone radiation on the volume, systolic velocity, salivary flow rate of parotid and submandibular gland between the dominant and non dominant side of mobile phone users.

Materials and Methods: A cross-sectional study was conducted in the Department of Oral Medicine and Radiology with the sample size of 100 (50 males and 50 females). Inclusion criteria were based on the frequency of mobile phone usage of more than two hours per day. Mobile phone usage was determined based on patient's answer to the questionnaire. Ultrasonography (USG) of both parotid and submandibular gland was done bilaterally to measure the volume of the glands and Colour Doppler of external background-color:inherit"carotid artery to measure systolic velocity. Modified Schirmer tear strips were used bilaterally to measure unstimulated salivary flow rate. The data was entered into MS excel and significance was calculated using independent sample t-test.

Results: In parotid gland, mean volume, mean systolic velocity and mean salivary flow rate were of higher value in the dominant side (14.22 +/- 2.17 mL; 15.14 +/- 3.74 cm/s; 0.37 +/- 0.26 mm/5 mins) compared to the non dominant side (13.76 +/- 2.14 mL; 14.53 +/- 3.39 cm/s; 0.24 +/- 0.2 mm/5 mins). In submandibular gland, mean volume, mean systolic velocity and mean salivary flow rate were of higher value in the dominant side (9.60 +/-1.96 mL; 15.70 +/- 6.44 cm/s; 0.30 +/- 0.22 mm/5 mins) compared to the non dominant side (8.88 +/- 2.17 mL; 13.87 +/- 4.83 cm/s; 0.26 +/- 0.21 mm/5 mins).

Conclusion: The volume, systolic velocity of blood flow, the salivary flow rate, of the parotid gland and submandibular gland were significantly more on the dominant side than the non dominant side of mobile phone usage. The study emphasised that prolonged mobile phone usage causes biological changes in salivary glands and its flow rate.

Open access paper:
https://www.jcdr.net/articles/PDF/17035/56667_CE[Vi]_F[SH]_PF1(AB_SHU)redo_PFA(SS)_PB(AB_SS)_PN(SS).pdf

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ELECTROMAGNETIC RADIATIONS ON THE FUNCTIONAL POTENTIAL OF SPERMATOZOA

Ranjitsingh AJA, Elizabeth MM, Dhasarathan P, Athinarayanan G. Electromagnetic radiations on the functional potential of spermatozoa. Res. J. Biotech. 17(10):12-17; 2022. doi: 10.25303/1710rjbt12017.

Abstract

The growing exposure to digital communication system and tools leads to radiation toxicity to the users. Unaware of the safety measures, even a kid at the age of one starts operating digital gadgets emitting radio frequency-electromagnetic radiations. Radiations from mobile phones, laptops, notepad, Wi-Fi or other devices are reported to be harmful beyond the permissible limit. So there is a growing concern for the overall health, reproductive and hormonal functions. Experimental studies were conducted by using a Wi-Fi network active laptop and live spermatozoa. The exposure of sperms to the source of EMF showed that the activity of the live sperms got reduced and mortality was observed depending on the exposure duration and the distance from EMF sources.

After 5h of exposure to RF-EMF source, the semen quality changed when compared with control. The vitality of sperm in the control was 95±1.0 after 2 hr and it was reduced to 60±1.5 percent at a distance of 1cm and 55±2.2 percent at a distance of 10 cm. After 5 hour exposure, the vitality was reduced to 63±1.86 at 1 cm distance and 70± 1.42 at 10 cm distance. The reduction in vitality of sperm after exposure to RFEMF source for 2 hour was 35% at 1cm and 40% at 10cm distance.

Conclusion

The present study on the impact of radiations from a laptop upon the functional mechanism of spermatozoa confirmed that operating the digital devices without precautionary measures and distance interferes with fertilizable ability of the sperms that may end in infertile marriage. The present users of laptop or other digital devices must be cautious about the possible fertility problems from such devices.

Open access paper:
https://worldresearchersassociations.com/Archives/RJBT/Vol(17)2022/October%202022/Electromagnetic%20radiations%20on%20the%20functional%20potential%20of%20spermatozoa.aspx

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DOES EXPOSURE TO RADIOFREQUENCY RADIATION (RFR) AFFECT THE CIRCADIAN RHYTHM OF REST-ACTIVITY PATTERNS AND BEHAVIORAL SLEEP VARIABLES IN HUMANS?

Singh MM, Chandel P, Pati A, Parganiha A. (2022) Does exposure to radiofrequency radiation (RFR) affect the circadian rhythm of rest-activity patterns and behavioral sleep variables in humans? Biological Rhythm Research, 53:9, 1414-1438, doi: 10.1080/09291016.2021.1945788.

Abstract

We evaluated the effects of the exposure to radio-frequency radiation emanating from the base transceiver station (BTS) on the characteristics of circadian rest-activity rhythm and behavioral sleep variables in humans. We performed this exploratory field study in a sample of 89 healthy subjects randomly chosen out of 1434 individuals surveyed for the purpose. We divided 89 subjects into five groups, including the control, as a function of distance from the BTS. The E-field strength was higher in the groups of the inter-tower region and between 0 and 150 m away from the BTS. The E-field (distance) did not significantly affect the circadian rhythm parameters and behavioral sleep variables, except a marginal delay in the peak timings of the rest-activity rhythm of subjects in the inter-tower and 300–500 m groups. Notable secondary effects of the factor gender were noticed on circadian amplitude, sleep efficiency, dichotomy index, and wake after sleep onset. We concluded that exposure to radiation from the BTS did not modulate actigraphy-based behavioral sleep variables of people residing around BTS installations. We recommend more extensive field-based studies with rigorous longitudinal designs to validate the effects of radiation from the BTS in humans.
https://www.tandfonline.com/doi/abs/10.1080/09291016.2021.1945788

EFFECTS OF CONTINUOUS PRENATAL AND POSTNATAL GLOBAL SYSTEM FOR MOBILE COMMUNICATIONS ELECTROMAGNETIC WAVES (GSM-EMW) EXPOSURE ON THE OXIDATIVE STRESS BIOMARKERS IN FEMALE RAT LIVER

Salameh M, Zeitoun-Ghandour S, Sabra L, Ismail L, Daher A, Bazzi A, Khalil M, Joumaa WH. Effects of continuous prenatal and postnatal global system for mobile communications electromagnetic waves (GSM-EMW) exposure on the oxidative stress biomarkers in female rat liver. Heliyon. 2022 Dec 17;8(12):e12367. doi: 10.1016/j.heliyon.2022.e12367.

Abstract

In light of the increased use of communication technologies, the harm caused by continuous exposure to emitted radiation on pregnancy and developing newborns is among the public concerns. Using Sprague-Dawley rats, our study investigates the effects of 24 h/day prenatal and postnatal 900 MHz radiofrequency electromagnetic radiation (RF-EMR) exposure of female rats on liver oxidative stress (OS) and other hepatic parameters at postnatal days (PND) 1, 9, and 21. Our results showed that RF-EMR exposure led to an increase in oxidative stress status as indicated by a significant elevation in MDA level at PND9 and PND21, a decrease in catalase (CAT) activity at all ages, a reduction (PND1 and PND9) in catalase amounts and mRNA expression, in addition to a decrease in GPx activity at PND21 in the exposed group. Current findings also showed a significant increase in cytoSOD at PND9 and 21 and a reduction in mitoSOD at PND21 in the exposed groups compared to the control groups. However, significant increases in glutathione peroxidase (GPx) level and mitoSOD activity were observed at all studied ages. Furthermore, cytoSOD activity showed a significant reduction in PND1, whereas in PND9 the value of this parameter increased compared to the non-exposed group. Moreover, while SOD1 mRNA expression increased at PND1, it decreased at PND9 and 21. However, GPx1 expression was shown to be always decreased in the exposed group. In addition, at PND1 and 9, exposed rats showed a similar response on Akt1, nuclear factor erythroïd 2-related factor 2 (Nrf-2), and intercellular adhesion molecule-1 (ICAM-1) expression. Therefore, an increased oxidative stress status produced from a continuous (24 h/day) GSM-modulated 900 MHz radiofrequency electromagnetic radiation (RF-EMR) exposure during the prenatal and postnatal periods may result in adverse health effects during future life stages.

Excerpt

Briefly, animals were exposed to radiation emitted by a device similar to the antennas of mobile phone stations with a frequency equal to 900 MegaHertz. This device generally consists of a radiofrequency signal (RF) generator (model RFS 900–64, RFPA, Artigues-près-Bordeaux, France) accompanied with RF-EMF antennas (local made) supported by a stand, and placed horizontally 100 cm above the cages containing rats (Figure 1). The generator's power was set to obtain a field intensity of 25 ± 0.4 V/m. A radiofrequency probe (PMM EP600, Narda Safety Test Solution, Hauppauge, NY, USA) monitored with computer software (Win EP 600, Narda Safety Test Solution) was used to check the level of RF-EMF exposure at 3 different periods (gestational day 1, PND1 and PND21). The liver-specific absorption rate (SAR) (0.783 W/kg) was calculated using the equation.

Open access paper: https://pubmed.ncbi.nlm.nih.gov/36590500/

RESEARCH ON ELECTROMAGNETIC RADIATION SAFETY ASSESSMENT OF CO-CONSTRUCTION AND SHARING 5G NETWORK

Senwen L, Zhizhong W, Huagang W, Shaochuan C. Research on Electromagnetic Radiation Safety Assessment of Co-construction and Sharing 5G Network. 2022 6th International Conference on Communication and Information Systems (ICCIS), 2022, pp. 27-34, doi: 10.1109/ICCIS56375.2022.9998130.

Abstract

Electromagnetic radiation safety of 5G base stations has been widely concerned by society and the public due to the accelerated development. This paper analyzes the electromagnetic radiation propagation characteristics of 5G mMIMO beam-forming, and monitors the field radiation level of the low-frequency 5G(Sub 6G) base station which co-constructed and shared by China Telecom and China Unicom in-situ real time, also studies and assesses the electromagnetic radiation safety of 5G co-construction and sharing network according to the international and China's 5G electromagnetic radiation limit standards.

Excerpts

Currently, the rated transmission power of commercial 5G macro station has specifications such as 160W, 200W, 240W and 320W, which is far more than the 40W to 60W transmission power of 4G macro stations.

At the same time, as 5G adopts a higher working frequency band and is affected by high-frequency attenuation, the coverage radius of 5G macro stations is about 300m to1500m, which is much smaller than the coverage radius of 4G macro stations of 1000m to 3500m, obviously, in order to ensure the same coverage quality, the number of 5G base stations is usually 3 to 5 times more than that of 4G.

As can be seen from Table I, for the 5G networks of these four operators in China, the maximum electromagnetic radiation limit (power density) of 5G(Sub 6G) base stations specified by China's national standard GB8702-2014 is between 40 μW/cm2 to 67 μW/cm2, and the maximum limit (power density) specified by HJ/T10.3-1996 in China's environmental protection industry is 8 μW/cm2 to 13.4 μW/cm2, but the maximum limit of electromagnetic radiation (power density) of 5G base stations specified by international standards ICNIRP2020 and IEEE C95.1-2019 can reach 1000 μW/cm2, obviously, the China's national standard of 5G base station radiation limit is 15 to 25 times harsher than that of other countries that mostly adopt international standard limits. If China's environmental protection industry standard HJ/10.3 is used, it is 75 to 125 times stricter than that of other countries that adopt international standards.

Conclusions

Although the beam-forming characteristic of the 5G mMIMO base station has strong beam directivity, and the electromagnetic radiation intensity of 5G base station also has a strong relationship with the user's download rate, however, in the most extreme application scenario of eMBB high-speed downlink lasting 6min without interruption, through frequency selection monitoring, the electromagnetic radiation level of 5G shared base stations with the maximum power of 320W and 200M working bandwidth in China's commercial network is far lower than China's national limit standard and international standard, which also shows that

the high power, high frequency and high speed 5G network does not necessarily mean the safety problem of electromagnetic radiation. In fact, the electromagnetic environment quality of the sensitive area around the base station can still meet the national standard.

In addition, considering that China's national standard limit requirements are 15-25 times stricter than international standards, most countries have adopted more relaxed limit requirements for public exposure to 5G electromagnetic radiation, therefore, combined with the in-situ monitoring results obtained under the extreme eMBB application scenarios, which are far lower than the requirements of the national limit standard GB8702- 2014, as long as the operators can timely do the pre-assessment of radiation risk before the base station construction and routine monitoring during operation, the electromagnetic radiation risk in sensitive areas covered by 5G. https://ieeexplore-ieee-org/iel7/9998130

THE TEMPORAL IMPRINT OF MOBILE PHONE EMISSION LEVEL WHEN RUNNING VARIOUS APPLICATIONS IN 4G VERSUS 5G NETWORKS

Miclaus S, Deaconescu DB, Vatamanu D, Buda AM. The temporal imprint of mobile phone emission level when running various applications in 4G versus 5G networks. 2022 International Symposium on Electronics and Telecommunications (ISETC), Timisoara, Romania, 2022, pp. 1-4, doi: 10.1109/ISETC56213.2022.10010000.

Abstract

Human exposure to electromagnetic fields emitted by mobile communications sources is dominated by the mobile phone radiation. Not only the dose of radiation is important, but also dose- or fluence-rate. In this regard, present research emphasizes the features of the dynamics of mobile terminal emission levels by means of statistics, nonlinear data analysis with recurrence quantification and time-frequency analyses. Time series of radiated electric field strengths were recorded and processed for a set of five mobile applications usage per communication standard. Both 4G-LTE emission channel of 20 MHz bandwidth and 5G-NR FR1 emission channel with a bandwidth of 40 MHz were studied. Differences between 4G and 5G emissions variabilities are presented, and application-specific features of the time imprint are highlighted.

Conclusions

An original approach was applied here for extracting the temporal imprint of mobile phone emissions when it was successively connected to 4G and 5G (sub-6GHz) networks. The same five types of mobile applications were investigated while running, from the point of view of statistics, recurrence quantification and time-frequency plots of normalized E-field strengths emitted during 24s of use.

The most significant findings were: a) upload and video call showed the highest differences between 4G and 5G field level distributions; b) 5G emissions are highly concentrated in the lower levels end, with small differences between applications, which is very dissimilar from 4G emissions; c) video call in 4G conducted to the highest slope of field level local accumulation in time; the same was true in 5G, if compared with the other applications running in the same standard; d) on average the 5G emissions showed coefficient of variations of field levels 45% higher than 4G emissions; e) correlation between 4G and 5G strings of field levels was the largest for file upload but lack of correlation resulted for voice call; f) recurrence

quantifications showed a degree of determinism present but no predictability; clear differences between 4G and 5G are emphasized while Poincare plots indicated that short-term variability is always consistently smaller than long-term variability in all 4G applications, and vice-versa is true for 5G emissions; h) time-frequency analysis emphasized again net differences between 4G and 5G emissions mainly for cases of upload, video call and streaming.

Both random and chaotic behaviour of emissions was emphasized so we conclude that too short time-series length might have hidden some significant features in the present preliminary results. Future work will be based on longer time- series data processing and analysis.
https://ieeexploreieeeorg.libproxy.berkeley.edu/stamp/stamp.jsp?tp=&arnumber=10010000&isnumber=10009039

ASSESSMENT OF EMF HUMAN EXPOSURE LEVELS DUE TO WEARABLE ANTENNAS AT 5G FREQUENCY BAND

Gallucci S, Bonato M, Benini M, Chiaramello E, Fiocchi S, Tognola G, Parazzini M. Assessment of EMF Human Exposure Levels Due to Wearable Antennas at 5G Frequency Band. Sensors (Basel). 2022 Dec 22;23(1):104. doi: 10.3390/s23010104.

Abstract

Background: This work aims to assess human exposure to EMF due to two different wearable antennas tuned to two 5G bands.

Methods: The first one was centered in the lower 5G band, around f = 3.5 GHz, whereas the second one was tuned to the upper 5G band, at 26.5 GHz. Both antennas were positioned on the trunk of four simulated human models. The exposure assessment was performed by electromagnetic numerical simulations. Exposure levels were assessed by quantifying the specific absorption rate averaged on 10 g of tissue (SAR10g) and the absorbed power density (Sab), depending on the frequency of the wearable antenna.

Results: the higher exposure values that resulted were always mainly concentrated in a superficial area just below the antenna itself. In addition, these resulting distributions were narrowed around their peak values and tended to flatten toward lower values in farther anatomical body regions. All the exposure levels complied with ICNIRP guidelines when considering realistic input power.

Conclusions: This work highlights the importance of performing an exposure assessment when the antenna is placed on the human wearer, considering the growth of wearable technology and its wide variety of application, particularly regarding future 5G networks.

Excerpt

To evaluate the interaction between the EMF emitted by the simulated wearable antennas and human tissues, the specific absorption rate (SAR) and the absorbed power density (Sab) were evaluated according to ICNIRP guidelines [28]. In more detail, the SAR was calculated as averaged over a cubical mass of 10 g (SAR10g), and the Sab was averaged over a square 4 cm2 surface area over the skin, that is, the most superficial tissue. Both SAR10g and Sab were

obtained with the input power to the antenna set as 1 W. The choice to estimate the SAR over the Sab and vice versa depended on the frequency of the wearable antenna.
Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9823937/

A HIGH-RESOLUTION PEDIATRIC FEMALE WHOLE-BODY NUMERICAL MODEL WITH COMPARISON TO A MALE MODEL

Ntolkeras G, Jeong H, Zollei L, Dmytriw AA, Purvaziri A, Lev MH, Grant PE, Bonmassar G. A high-resolution pediatric female whole-body numerical model with comparison to a male model. Phys Med Biol. 2022 Dec 6. doi: 10.1088/1361-6560/aca950.

Abstract

Objective: Numerical models are central in designing and testing novel medical devices and in studying how different anatomical changes may affect physiology. Despite the numerous adult models available, there are only a few whole-body pediatric numerical models with significant limitations. In addition, there is a limited representation of both male and female biological sexes in the available pediatric models despite the fact that sex significantly affects body development, especially in a highly dynamic population. As a result, we developed Athena, a realistic female whole-body pediatric numerical model with high-resolution and anatomical detail.

Approach: We segmented different body tissues through Magnetic Resonance Imaging (MRI) and Computed Tomography (CT) images of a healthy 3.5-year-old female child using 3D Slicer. We validated the high anatomical accuracy segmentation through two experienced sub-specialty-certified neuro-radiologists and the inter and intra-operator variability of the segmentation results comparing sex differences in organ metrics with physiologic values. Finally, we compared Athena with Martin, a similar male model, showing differences in anatomy, organ metrics, and MRI dosimetric exposure.

Main results: We segmented 267 tissue compartments, which included 50 brain tissue labels. The tissue metrics of Athena displayed no deviation from the literature value of healthy children. We show the variability of brain metrics in the male and female models. Finally, we offer an example of computing Specific Absorption Rate (SAR) and Joule heating in a toddler/preschooler at 7T MRI.

Significance: This study introduces a female realistic high-resolution numerical model using MRI and CT scans of a 3.5-year-old female child, the use of which includes but is not limited to radiofrequency safety studies for medical devices (e.g., an implantable medical device safety in MRI), neurostimulation studies, and radiation dosimetry studies. This model will be open source and available on the Athinoula A. Martinos Center for Biomedical Imaging website.
Open access paper: https://iopscience.iop.org/article/10.1088/1361-6560/aca950

HUMAN HEALTH RISK ASSESSMENT OF 4-12 GHZ RADAR WAVES USING CST STUDIO SUITE SOFTWARE

Fereidouni F, Mohammadi ST, Faramarzi Shahraki V, Jahantigh F. Human Health Risk Assessment of 4-12 GHz Radar Waves using CST STUDIO SUITE Software. J Biomed Phys Eng. 2022 Jun 1;12(3):285-296. doi: 10.31661/jbpe.v0i0.1272.

Abstract

Background: The application of radar systems in telecommunications and aerospace science is important. However, engineering department's staff various tissues are always under chronic radiation generated by the radar fields which may affect health.

Objective: This study aims to evaluate the risk of radar wave exposure and to explore the effects and limitations.

Material and methods: In this simulation study, an adult body model versus 1 watt source with a distance of 50 centimeters exposure has been simulated using the CST STUDIO SUITE. Furthermore, various physical and electrical properties of each tissue and organ for different frequencies and exposure times have been studied. The exposure dose limitations have been considered using the International Commission on Non-Ionizing Radiation Protection (ICNIRP) safety and health guide report.

Results: Total body absorbed doses for 4 GHz, 8 GHz, and 12 GHz frequency, and 6 min, 4 h, and 30 days exposure time, have been calculated as 1.136×10-5, 1.598×10-5, 1.58×10-3, 1.521×10-5, 3.122×10-5, 4.52×10-3,4.1×10-5, 10-4, and 10-2, respectively.

Conclusion: It has shown that the internal organs of the body and head will be under more risk by reducing radar frequencies from 12 GHz to 4 GHz. On the other hand, the higher frequency can cause a higher risk to the human skin. In addition, the maximum Specific Absorption Rate (SAR) for each case has been calculated. The results show that for this normalized source, the safety criteria have been respected, but for a higher source, the calculations must be repeated.

Conclusion

In this paper, an accurate and comprehensive model of the adult body tissues using the CST Studio Suite software is developed. The effect of EM radiation on the human body was studied for the frequency range of 4 to 12 GHz over a specified period of 6 min, 4 h and 30 days. It can be concluded that the effects are inversely related to the frequency increase. In other words, the longer the wavelength of the electromagnetic field can cause further penetration in the human body and severe effects in the vital organs of the body. The longer exposure time can cause a severe effect. In addition, by examining the pattern of wave propagation in the body, it was seen that in the oral cavities filled with the air, there is a loss of wavelength and the waves tend to fall into the inner tissues which have absorption coefficient. Excluding the body skin, the power loss in the other organs monolithically decreased with frequency increase, and the power loss increases by the exposure time so that for 30 days exposure, it has nearly 2 orders of magnitude more absorption at different organs. The power loss diagram, SAR diagram, and the body organs risk caused by radar waves show the rate of

vulnerability of the abdominal cavity and the head. The risk of the body skin disease in the lower frequencies has increased.

Furthermore, the skin surface is more vulnerable and the chance of skin complications increases at higher frequencies up to 12 GHz. It should also be emphasized that for the body of those people whose workplace interact with radar waves exceeding the limit point of -10.96 dB, the critical risk of the body's vital organs increases. As a result, the standard limits should be considered for safety and health of the staff in the radar sites.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9175128/

GROUNDING (EARTHING) AS RELATED TO ELECTROMAGNETIC HYGIENE: AN INTEGRATIVE REVIEW

Jamieson IA. Grounding (earthing) as related to electromagnetic hygiene: An integrative review. Biomedical Journal, 2022, doi:10.1016/j.bj.2022.11.005.

Abstract

There are a growing number of studies investigating how grounding (earthing) the body may benefit biological performance and aid the treatment of non-communicable diseases. Research also indicates how biological grounding initiatives can sometimes be compromised, or inappropriate, and the need to take additional factors into account as potential contributory factors, or confounders, to expected results. It is proposed that expanding electromagnetic hygiene measures beyond biological grounding alone may help reduce spread of communicable diseases, incidence of respiratory conditions, neurodegenerative disease and all-cause mortality. Identifying potential synergies that exist could enable multilevel interventions to further increase the efficacy of measures. It is hoped that this review will help act as a catalyst to inspire and inform multi-disciplinary research within these topic areas, best practices and policies to help drive medical innovation, reduce health burdens, improve bioelectromagnetic-based therapies, and influence the general design of the built environment and next- generation technologies.

Open access paper: https://www.sciencedirect.com/science/article/pii/S2319417022001573

ASSESSMENT OF THE ELECTROMAGNETIC RADIATION EXPOSURE AT ELECTRIC VEHICLE CHARGING FACILITIES

Bae H, Park S. Assessment of the Electromagnetic Radiation Exposure at EV Charging Facilities. Sensors (Basel). 2022 Dec 23;23(1):162. doi: 10.3390/s23010162

Abstract

As the number of electric vehicles (EV) increases, the number of EV chargers also increases. Charging infrastructure will be built into our close environment. Because of this, the assessment of the electromagnetic field exposure generated from the charger is an important issue. This paper valuates the electromagnetic field exposure of six EV chargers. To assess the level of exposure of EV chargers, the electromagnetic fields from six chargers were measured and analyzed. In addition, measured electromagnetic field exposure levels were evaluated against ICNIRP guidelines. Higher electromagnetic fields were measured with standard chargers than with fast chargers. For the fast charger in the charging state, the magnetic field increased with the charging current. Electromagnetic field exposures for all six chargers did

not exceed standard limits. The results of the assessment of the electromagnetic field exposure of the six EV chargers will contribute to the establishment of standards for the evaluation of the electromagnetic field exposure of the EV chargers in the future.

Conclusion

In this study, electromagnetic field exposure assessment results of six EV chargers were presented. These results show the location where the electromagnetic field is the highest measured among electric vehicle chargers in the charging situation. They also show the correlation between changes in the electromagnetic field and changes in the SoC. The measured value of the electromagnetic field was analyzed by comparing it with domestic and global electromagnetic field intensity standard. The domestic electromagnetic field intensity standards were in agreement with the ICNIRP guidelines revised in 1998 and were analyzed based on them.

Six EV chargers were selected for measurement. The level of exposure to electromagnetic fields was confirmed by precisely measuring six types of chargers in RMS mode under charging conditions. In addition, the electromagnetic field changed as the SoC changed. Because of RMS precision measurement, a relatively higher electromagnetic field was emitted from a standard charger than from a fast charger. The maximum electric field was measured at the standard stand-type B handle, and it was 430 V/m, corresponding to an EI of 10%. The maximum magnetic field was measured on a standard wall-mounted body and was 46 A/m, corresponding to an EI of 69%. None of the six chargers exceeded the electromagnetic field protection standard.

Changes in electric and magnetic fields were confirmed by the changes in the SoC [state of charge] of six chargers. In the case of fast charging facilities, as the charging power and current gradually decreased, it was confirmed that the level of magnetic field strength decreased accordingly. In the case of standard charging facilities, the correlation between charging power, voltage, current, and electric and magnetic field strength could not be confirmed. In addition, changes in the electromagnetic field were observed with changes in the SoC. Generally, the maximum value of the electromagnetic field was measured in the measurement results by the change in the SoC. This result indicates the need to verify electromagnetic field measurements as the change in the SoC.

Because of these results, the measurement procedure when preparing a method to evaluate the amount of exposure to electromagnetic fields in EV charging facilities is worth reviewing in the future. When charging an EV, the measurement location of maximum electromagnetic field exposure is necessary. Therefore, first, an understanding of the overall electromagnetic field strength of the charging facility is necessary. The maximum value after measurements according to the change from 0% to 100% of the SoC at the location of maximum exposure is worth recording.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9824816/

ELECTROMAGNETIC RADIATION SAFETY ON FAR-FIELD WIRELESS POWER TRANSFER IN IOT

Ma F, Liu X, Ansari N. Electromagnetic Radiation Safety on Far-field Wireless Power Transfer in IoT. GLOBECOM 2022 - 2022 IEEE Global Communications Conference, Rio de Janeiro, Brazil, 2022, pp. 4995-5000, doi: 10.1109/GLOBECOM48099.2022.10001490.

Abstract

Nowadays, Far-field Wireless Power Transfer (FWPT) has attracted many research efforts to conveniently power the Internet of Things (IoT) devices. Electromagnetic Radiation (EMR) safety in FWPT has brought much attention from the public. Existing works on FWPT mainly focus on improving the remote charging efficiency but overlooking the effects of EMR. A few works consider EMR safety but do not present accurate EMR quantization analysis because there lacks an accurate EMR computing model in IoT wireless charging scenario. In this paper, in order to evaluate and avoid the EMR's harmful impact, we first propose an accurate theoretical calculation equation for EMR and the concept of Charging Restricted Area (CRA). In the wireless charging area on a 2- dimensional plane, according to the EMR computing model, we further maximize the overall charging power by adjusting the power of chargers and ensure that the EMR in this area is lower than the EMR safety threshold.

The wireless charging EMR safety problem is formulated as a linear programming problem with infinite constraints. To re-express the wireless charging EMR safety problem as a typical linear programming problem with finite constraints, the Sampling Safety Charging (SSC) algorithm is proposed. We have conducted extensive experiments to validate our proposed algorithm; the simulation results show that the performance achieved by our algorithm outperforms that achieved by the distributed RObustlySafE (ROSE) algorithm.

https://ieeexplore.ieee.org/document/10001490

COVERAGE FACTORS FOR EFFICIENT DEMONSTRATION OF COMPLIANCE OF LOW-FREQUENCY MAGNETIC NEAR-FIELD EXPOSURES WITH BASIC RESTRICTIONS

Xi J, Christ A, Kuster N. Coverage factors for efficient demonstration of compliance of low-frequency magnetic near-field exposures with basic restrictions. Phys Med Biol. 2022 Dec 2. doi: 10.1088/1361-6560/aca875.

Abstract

Regulators require that wireless power transfer (WPT) systems and other strong magnetic field sources are compliant with the basic restrictions (BR) defined as the limits of the fields induced in the human body, i.e., the induced electric field/current density/specific absorption rate limits. This can be achieved by demonstrating compliance with the reference levels (RL) defined in air without the human body, i.e., the incident electric/magnetic field limits. Local sources, such as WPT transmitters, generate non-uniform fields that can locally exceed the RL while the induced fields are still well below the BR. In these cases, robust compliance with BR can be demonstrated, generally requiring a large number of simulations. In this study, we proposed an efficient evaluation using a homogeneous phantom and applying a coverage factor to account for the local field enhancements caused by the dielectric contrasts of the highly inhomogeneous human tissues. The generally applicable coverage factors were derived from a statistical analysis of the field enhancements observed on four magnetic near-field sources placed at different separation distances (2-80 mm) and locations on the back of 12 anatomical models. The field enhancements were characterized by the ratios between the

peak induced fields in the anatomical models and those in the homogeneous half-space phantom (εr= 55, σ = 0.75 S/m, ρ = 1,000 kg/m3) at the same distance. The resulting 99th percentile coverage factors range from 1 and 9 depending on the dosimetric quantity. The use of these coverage factors reduces the compliance testing effort from hundreds of simulations to only one, and makes experimental testing feasible without the support of simulations. The study also demonstrates that running only a few use-case simulations with anatomical models may underestimate the exposure by more than 10 dB. https://iopscience.iop.org/article/10.1088/1361-6560/aca875

EVALUATION OF COGNITIVE FUNCTIONS AND EEG RECORDS IN RATS EXPOSED TO 2.45 GHZ ELECTROMAGNETIC FIELD

Yucel H, Dundar NO, Doguc DK, Uguz C, Celik O, Aksoy FT, Nazıroglu M, Comlekci S, Dundar B. Evaluation of cognitive functions and EEG records in rats exposed to 2.45 GHz electromagnetic field. Int J Radiat Res 2022, 20(4): 753-760.

Abstract

Background: Electromagnetic fields may primarily affect cognitive functions. It has not been elucidated how electromagnetic radiation affects the brain, particularly in the young age group. We aimed to examine the cognitive function, expression of N-methyl-D-aspartate receptors (NMDA), and EEG alterations in weaned rats exposed to a 2.45 GHz electromagnetic field.

Materials and Methods: Twenty-one weaned (21 days old) male Wistar Albino rats were divided into two groups as experimental group (n=12) and control group (n=9). Animals in the experimental group were exposed to a 2.45 GHz electromagnetic field for one hour a day for more than 28 days. At the end of this period, rats were subjected to training and learning test using Morris Water Maze. After obtaining EEG records, hippocampi were removed. 2A and 2B subunits of NMDA receptors were studied in hippocampal homogenates using the Western Blot method.

Results: There were no statistically significant differences between the two groups in measures of latency to target quadrant, time spent in the target quadrant, and average swim speed as compared in Morris water maze. However, the time to arrive at the visible platform was significantly longer in experimental animals. There were no statistically significant differences in expression of 2A and 2B subunits of NMDA receptors between the two groups. Evaluation of EEG records revealed that spike frequency was significantly higher and time to first spike was significantly shorter in the experimental group.

Conclusion: These results indicated that a 2.45 GHz electromagnetic field might negatively affect EEG, motivation, and attention, particularly in the young age group.

Open access paper: http://ijrr.com/article-1-4460-en.pdf

EFFECTS OF ELF-PEMF EXPOSURE ON SPONTANEOUS ALTERNATION, ANXIETY, MOTOR CO-ORDINATION AND LOCOMOTOR ACTIVITY OF ADULT WISTAR RATS AND VIABILITY OF C6 (GLIAL) CELLS IN CULTURE

Tekam CKS, Majumdar S, Kumari P, Prajapati SK, Sahi AK, Shinde S, Singh R, Samaiya PK, Patnaik R, Krishnamurthy S, Mahto SK. Toxicology. 2022 Dec 24;485:153409. doi: 10.1016/j.tox.2022.153409.

Abstract

The effects of ELF-PEMF exposure on spontaneous alternation, anxiety, motor coordination, and locomotor activity have been discussed in various pre-clinical and clinical settings. Several epidemiological and experimental studies have demonstrated the potential effects of ELF-PEMF when exposed > ∼1 h/day; however, very few studies have focused on understanding the influence of ELF-PEMF exposure of 1-3 mT with an exposure duration of < 1 h/day on spontaneous alternation, anxiety, motor coordination, and locomotor activity. Hence, we attempted to study the effects of ELF-PEMF exposure of 1-3 mT, 50 Hz with an exposure duration of 20 min each with a 4 h gap (2 times) on the cellular proliferation and morphologies of C6 (Glial) cells and spontaneous alternation, anxiety, motor coordination and locomotor activity of Wistar rats under in vitro and in vivo conditions, respectively. The results showed that ELF-PEMF exposure did not induce any significant levels of cellular fragmentation and changes in the morphology of glial cells. Also, the outcomes revealed no noticeable effects on spontaneous alternation, anxiety, motor coordination, and locomotor activity in PEMF-exposed groups compared with the control. No undesirable side effects were observed at the highest dose (B=3 mT). We also performed histological analysis of the selected brain sections (hippocampus and cortex) following ELF-PEMF exposure. Incidentally, no significant changes were observed in cortical cell counts, tissue structure, and morphology.

https://pubmed.ncbi.nlm.nih.gov/36572170/

THE EFFECTS OF PRENATAL AND POSTNATAL EXPOSURE TO 50-HZ AND 3 MT ELECTROMAGNETIC FIELD ON RAT TESTICULAR DEVELOPMENT

Ersoy N, Acikgoz B, Aksu I, Kiray A, Bagriyanik HA, Kiray M. The Effects of Prenatal and Postnatal Exposure to 50- Hz and 3 mT Electromagnetic Field on Rat Testicular Development. Medicina (Kaunas). 2022 Dec 29;59(1):71. doi: 10.3390/medicina59010071.

Abstract

Background and Objectives: It has been shown that electromagnetic fields (EMFs) have negative effects on the reproductive system. The biological effects of EMF on the male reproductive system are controversial and vary depending on the frequency and exposure time. Although a limited number of studies have focused on the structural and functional effects of EMF, the effects of prenatal and postnatal EMF exposure on testes are not clear. We aimed to investigate the effects of 50-Hz, 3-mT EMF exposure (5 days/wk, 4 h/day) during pre- and postnatal periods on testis development. Materials and Methods: Pups from three groups of Sprague-Dawley pregnant rats were used: Sham, EMF-28 (EMF-exposure applied during pregnancy and until postnatal day 28), EMF-42 (EMF-exposure applied during pregnancy and until postnatal day 42). The testis tissues and blood samples of male offspring were collected on the postnatal day 42. Results: Morphometric analyses showed a decrease in seminiferous tubule diameter as a result of testicular degeneration in the EMF-42 group. Follicle- stimulating hormone (FSH) and luteinizing hormone (LH) levels were decreased in the

EMF-42 group. Lipid peroxidation levels were increased in both EMF groups, while antioxidant levels were decreased only in the EMF-28 group. We found decreased levels of vascular endothelial growth factor (VEGF) and insulin-like growth factor-1 (IGF1) in the EMF-42 group, and decreased levels of the SRC homology 3 (SH3) and multiple ankyrin repeat domain (SHANK3) in the EMF-28 group in the testis tissue. Conclusions: EMF exposure during pre- and postnatal periods may cause deterioration in the structure and function of testis and decrease in growing factors that would affect testicular functions in male rat pups. In addition to the oxidative stress observed in testis, decreased SHANK3, VEGF, and IGF1 protein levels suggests that these proteins may be mediators in testis affected by EMF exposure. This study shows that EMF exposure during embryonic development and adolescence can cause apoptosis and structural changes in the testis.
Open access paper: https://www.mdpi.com/1648-9144/59/1/71

EFFECTS OF 150 KHZ INTERMEDIATE FREQUENCY ELECTROMAGNETIC RADIATION ON FERTILITY INDICATORS IN MALE RATS

Sundaram V, Mohammed S, Zyuzikov N. Effects of 150 kHz intermediate frequency electromagnetic radiation on fertility indicators in male rats. Heliyon. 8(12). 2022. doi: 10.1016/j.heliyon.2022.e12228.

Abstract

Background The present study aimed to evaluate the effects of whole-body exposure to 150 kHz Intermediate- frequency electromagnetic radiation (IF EMR) on fertility indicators of male rats since human exposure to this frequency has increased in recent years. Fourteen adult male Sprague-Dawley rats were used in this study. The rats were randomly divided into a control and an EMR group (n = 7/group). The EMR group was continuously irradiated with 150 kHz EMR for 8 weeks. Male fertility indicators, body mass, testicular mass, rectal temperature, testicular histology, histometry, sperm analysis, and serum gonadotrophic hormone levels were evaluated.

Results The study showed no negative effect on body mass (grams) (323.78 ± 37.09 to 305.09 ± 26.36; p = 0.72), rectal temperature (Control: 34.5 °C–35.8 °C; EMR: 34.4 °C–36.1 °C; p < 0.05), and testicular histology. There were significant reductions in left and right testicular mass (1.04 ± 0.10 to 0.96 ± 0.32: p = 0.03 and 1.02 ± 0.08 to 0.96 ± 0.35 p = 0.04, respectively), interstitial cell count/1000 μm2 (5.33 ± 0.56 to 4.47 ± 0.48; p = 0.01), sperm motility trajectories (p = 0.05) and sperm distal cytoplasmic droplet (%) (2.27 ± 2.28 to 6.84 ± 5.01; p = 0.05). A significant increase in follicle-stimulating hormone levels was observed (13.44 ± 6.38 IU/ml to 26.96 ± 8.07 IU/ml; p = 0.01).

Conclusions Most male fertility parameters of rats in the present study were not affected by 8 weeks of whole- body exposure to 150 kHz EMR. However, significant decreases in testicular mass, interstitial cell count/1000 μm2, sperm motility trajectories, and distal cytoplasmic droplets were observed, as well as an increase in FSH level.
Open access paper: https://www.sciencedirect.com/science/article/pii/S2405844022035162

MAGNETIC FIELDS PRODUCED BY SUBSEA HIGH-VOLTAGE DIRECT CURRENT CABLES REDUCE SWIMMING ACTIVITY OF HADDOCK LARVAE

Cresci A, Durif CMF, Larsen T, Bjelland R, Skiftesvik AB, Browman HI. Magnetic fields produced by subsea high- voltage direct current cables reduce swimming activity of haddock larvae (Melanogrammus aeglefinus). PNAS Nexus. 2022 Aug 27;1(4):pgac175. doi: 10.1093/pnasnexus/pgac175.

Abstract

High-voltage direct current (HVDC) subsea cables are used to transport power between locations and from/to nearshore and offshore facilities. HVDC cables produce magnetic fields (B-fields) that could impact marine fish. Atlantic haddock (Melanogrammus aeglefinus) is a demersal fish that is at risk of exposure to anthropogenic B- fields. Their larvae drift over the continental shelf, and use the Earth's magnetic field for orientation during dispersal. Therefore, anthropogenic magnetic fields from HVDC cables could alter their behavior. We tested the behavior of 92 haddock larvae using a setup designed to simulate the scenario of larvae drifting past a B-field in the intensity range of that produced by a DC subsea cable. We exposed the larvae to a B-field intensity ranging from 50 to 150 µT in a raceway tank. Exposure to the B-field did not affect the spatial distribution of haddock larvae in the raceway. Larvae were categorized by differences in their exploratory behavior in the raceway. The majority (78%) of larvae were nonexploratory, and exposure to the artificial B-field reduced their median swimming speed by 60% and decreased their median acceleration by 38%. There was no effect on swimming of the smaller proportion (22%) of exploratory larvae. These observations support the conclusion that the swimming performance of nonexploratory haddock larvae would be reduced following exposure to B-field from HVDC cables. The selective impact on nonexploratory individuals, and the lack of impact on exploratory individuals, could have population-scale implications for haddock in the wild.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9802485/

WIRELESS TECHNOLOGY IS AN ENVIRONMENTAL STRESSOR REQUIRING NEW UNDERSTANDING AND APPROACHES IN HEALTH CARE

McCredden JE, Cook N, Weller S, Leach V. Wireless technology is an environmental stressor requiring new understanding and approaches in health care Front. Public Health, 20 December 2022. doi: 10.3389/fpubh.2022.986315.

Abstract

Electromagnetic signals from everyday wireless technologies are an ever-present environmental stressor, affecting biological systems. In this article, we substantiate this statement based on the weight of evidence from papers collated within the ORSAA database (ODEB), focusing on the biological and health effects of electromagnetic fields and radiation. More specifically, the experiments investigating exposures from real-world devices and the epidemiology studies examining the effects of living near mobile phone base stations were extracted from ODEB and the number of papers showing effects was compared with the number showing no effects. The results showed that two-thirds of the experimental and epidemiological papers found significant biological effects. The breadth of biological and health categories where effects have been found was subsequently explored, revealing hundreds of papers showing fundamental biological processes that are impacted, such as protein damage, biochemical changes and oxidative stress. This understanding is targeted

toward health professionals and policy makers who have not been exposed to this issue during training. To inform this readership, some of the major biological effect categories and plausible mechanisms of action from the reviewed literature are described. Also presented are a set of best practice guidelines for treating patients affected by electromagnetic exposures and for using technology safely in health care settings. In conclusion, there is an extensive evidence base revealing that significant stress to human biological systems is being imposed by exposure to everyday wireless communication devices and supporting infrastructure. This evidence is compelling enough to warrant an update in medical education and practice.

Excerpt

Indeed, the data from ODEB (see Table 1) corroborates the above research findings, by showing that the type of signal used: real or simulated, can affect study outcomes. Within the 1,106 relevant experimental papers selected from ODEB using the quality of reporting criteria above, there were proportionally more "Effect" outcomes when the experiments used real-world signals and proportionally more "No Effect" outcomes when simulated signals were used. This relationship between signal type and biological effect outcome was statistically significant ($p < 0.05$), indicating that signal type needs to be clearly articulated in reporting because it can potentially bias outcomes. This result also supports our decision to investigate further only the experimental papers that used real-world signals. For these papers, shown in the final column of Table 1, there was a significantly higher proportion of papers showing effects (79.1%) than those reporting no effects (15.3%).

Conclusion

Man-made radiofrequency signals from everyday devices and communications technology infrastructure constitute an environmental stressor, well-documented as creating various adverse biological effects. Plausible mechanisms in which harm can occur initially on a cellular level have been proposed, and these mechanisms are known to have subsequent downstream health effects. The application of the ICRP radiation protection philosophy and framework for the protection of members of the public is over 90 years in the making and is absent in setting exposure limits for this form of (wireless) radiation. The extensive evidence base is compelling enough to call for an update in medical education and practice. Out of care for their patients, healthcare workers may develop their understanding using the practical methods introduced in this discussion paper. Furthermore, modern institutional practices need to be reviewed to ensure that any harm from electromagnetic fields is reduced as much as reasonably possible while still providing optimal health care.

Open access paper: https://www.frontiersin.org/articles/10.3389/fpubh.2022.986315/full

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CONTROVERSY IN ELECTROMAGNETIC SAFETY

Chou CK. Controversy in Electromagnetic Safety. Int J Environ Res Public Health. 2022 Dec 16;19(24):16942. doi: 10.3390/ijerph192416942.

Abstract

The dramatic increase in electromagnetic fields (EMFs) in the environment has led to public health concerns around the world. Based on over 70 years of research in this field, the World Health Organization (WHO) has concluded that scientific knowledge in this area is now more extensive than for most chemicals and that current evidence does not confirm the existence

of any health consequences from exposure to low-level electromagnetic fields. However, controversy on electromagnetic safety continues. Two international groups, the International Committee on Electromagnetic Safety of the Institute of Electrical and Electronics Engineers (IEEE) and the International Commission on Non-Ionizing Radiation Protection, have been addressing this issue for decades. While the goal of both groups is to provide human exposure limits that protect against established or substantiated adverse health effects, there are groups that advocate more stringent exposure limits, based on possible biological effects. Both biological and engineering complexities make the validity of many EMF studies questionable. Controversies in research, publication, standards, regulations and risk communication concerning electromagnetic safety will be addressed in this article. The WHO is conducting systematic reviews on the RF biological effects literature. If scientists would discuss the safety issues of EMFs based on validated scientific facts and not on unreproducible possible effects and opinions, the controversy would be minimized or resolved.
Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9778992/

CONDUCTING EVALUATIONS OF EVIDENCE THAT ARE TRANSPARENT, TIMELY AND CAN LEAD TO HEALTH-PROTECTIVE ACTIONS

Chartres N, Sass JB, Gee D, Bălan SA, Birnbaum L, Cogliano VJ, Cooper C, Fedinick KP, Harrison RM, Kolossa- Gehring M, Mandrioli D, Mitchell MA, Norris SL, Portier CJ, Straif K, Vermeire T. Environ Health. 2022 Dec 5;21(1):123. doi: 10.1186/s12940-022-00926-z.

Abstract

Background: In February 2021, over one hundred scientists and policy experts participated in a web-based Workshop to discuss the ways that divergent evaluations of evidence and scientific uncertainties are used to delay timely protection of human health and the environment from exposures to hazardous agents. The Workshop arose from a previous workshop organized by the European Environment Agency (EEA) in 2008 and which also drew on case studies from the EEA reports on 'Late Lessons from Early Warnings' (2001, 2013). These reports documented dozens of hazardous agents including many chemicals, for which risk reduction measures were delayed for decades after scientists and others had issued early and later warnings about the harm likely to be caused by those agents.

Results: Workshop participants used recent case studies including Perfluorooctanoic acid (PFOA), Extremely Low Frequency - Electrical Magnetic Fields (ELF-EMF fields), glyphosate, and Bisphenol A (BPA) to explore myriad reasons for divergent outcomes of evaluations, which has led to delayed and inadequate protection of the public's health. Strategies to overcome these barriers must, therefore, at a minimum include approaches that 1) Make better use of existing data and information, 2) Ensure timeliness, 3) Increase transparency, consistency and minimize bias in evidence evaluations, and 4) Minimize the influence of financial conflicts of interest.

Conclusion: The recommendations should enhance the production of "actionable evidence," that is, reliable evaluations of the scientific evidence to support timely actions to protect health and environments from exposures to hazardous agents. The recommendations are applicable to policy and regulatory settings at the local, state, federal and international levels.

Open access paper: https://ehjournal.biomedcentral.com/articles/10.1186/s12940-022-00926-z

EFFECT OF RADIOFREQUENCY ELECTROMAGNETIC RADIATION EMITTED BY MODERN CELLPHONES ON SPERM MOTILITY AND VIABILITY: AN IN VITRO STUDY

Chu KY, Khodamoradi K, Blachman-Braun R, et al. Effect of Radiofrequency Electromagnetic Radiation Emitted by Modern Cellphones on Sperm Motility and Viability: An In Vitro Study. Eur Urol Focus. 2022;S2405- 4569(22)00247-4. doi:10.1016/j.euf.2022.11.004.

Abstract

Background: Cellphones emit radiofrequency electromagnetic radiation (RF-EMR) for transmission of data for social media communication, web browsing, and music/podcast streaming. Use of Bluetooth ear buds has probably prolonged the time during which cellphones reside in the trouser pockets of men. It has been postulated that RF-EMR increases oxidative stress and induces free radical formation.

Objective: To investigate the effect of wireless-spectrum (4G, 5G, and WiFi) RF-EMR emitted by modern smartphones on sperm motility and viability and explore whether these effects can be mitigated using a physical barrier or distance.

Design, setting, and participants: Semen samples were obtained from fertile normozoospermic men aged 25-35 yr. A current-generation smartphone in talk mode was used as the RF-EMR source. A WhatsApp voice call was made using either 4G, 5G, or WiFi wireless connectivity. We determined if exposure effects were mitigated by either a cellphone case or greater distance from the semen sample.

Outcome measurements and statistical analysis: The semen samples were analyzed according to 2010 World Health Organization laboratory guidelines. Statistical analysis was performed using SPSS v.28.

Results and limitations: We observed decreases in sperm motility and viability with WiFi exposure but not with exposure to 4G or 5G RF-EMR. With large variability among smartphones, continued research on exposure effects is needed.

Conclusions: Our exploratory study revealed that sperm motility and viability are negatively impacted by smartphones that use the WiFi spectrum for data transmission.

Patient summary: We looked at the effect of cellphone use on sperm motility and viability. We found that cellphones using WiFi connectivity for data usage have harmful effects on semen quality in men.

https://pubmed.ncbi.nlm.nih.gov/36379868/

MULTI-OBJECTIVE OPTIMISATION OF HUMAN EXPOSURE FOR VARIOUS 5G NETWORK TOPOLOGIES IN SWITZERLAND

Castellanos G, De Gheselle S, Martens L, Kuster N, Joseph W, Deruyck M, Kuehn S. Multi-objective optimisation of human exposure for various 5G network topologies in Switzerland. Computer Networks.216, 2022. doi: 10.1016/j.comnet.2022.109255.

Abstract

The constant increase in the required user capacity and the evolution of wireless network technologies impact the exposure that users experience from wireless networks. This paper evaluates various 5G network topologies regarding human exposure, mobile communication quality, and sustainability. We assess human exposure, based on a novel Exposure Ratio (ER) metric, in 5G networks that include Massive Multiple-Input Multiple- Output (MaMIMO) and compare them with existing 4G deployments in three environments in Switzerland. The quality and sustainability of mobile communication are evaluated by extrapolating data rates from mobile operators to the year 2030. A multi-objective optimisation algorithm is implemented to design the 5G network topologies, maximising the user coverage while minimising the downlink (DL) and uplink (UL) exposure. An extensive set of simulations investigated three municipalities, three operators plus one unified network, three use cases (UL/DL data rates), three scenarios (indoor and outdoor coverage), and two optimisation methods.

The study results confirm that the human exposure in a 5G network is dominated by the UL being ten times larger than the DL exposure. Furthermore, comparing a 5G deployment with 10 times the traffic capacity of a real 4G network, DL exposure increases by 36% on average, and UL exposure decreases by up to 75% depending on the scenario. Regarding indoor coverage versus outdoor only, our results show that DL exposure can be reduced by a factor of 10 if only outdoor coverage is targeted. Finally, the study concludes that from the human exposure perspective, the ideal network should use 5G MaMIMO and be optimised for both UL and DL exposure.

https://www.sciencedirect.com/science/article/pii/S1389128622003231

EMF EXPOSURE LEVEL FOR UPLINK AND DOWNLINK OF 5G NETWORK USING RAY TRACING APPROACH

Salem, M.A., Lim, H.S., Chua, M.Y., Chien, S.F., Zarakovitis, C.C., Ng , C.Y., Rahman, N.Z.A., 2022. Investigation of EMF Exposure Level for Uplink and Downlink of 5G Network Using Ray Tracing Approach. International Journal of Technology. Volume 13(6), pp. 1298-1307.

Abstract

To provide enhanced mobile services, the 5G system is expected to further densify its network infrastructure and scale up the deployment of massive antenna arrays that emit high-energy beams using the millimeter wave spectrum. These radically new features will significantly impact the EMF exposure level in the 5G networks. In this paper, EMF exposure for 5G mobile networks in a dense urban environment is investigated using a raytracing approach for the uplink (UL) and downlink (DL). A massive multi-input multi-output antenna with multiuser beamforming capability is considered for the 5G base station. For DL, the maximum rate transmission (MRT) technique is used to direct the beams toward all the active users, and total power density (PD) is used to evaluate the EMF exposure level. On the other hand, EMF exposure due to UL is investigated using electric field strength and specific absorption rate

(SAR). The proposed ray-tracing based EMF evaluation framework exploits detailed information of the scenarios, including 3D building geometry, EM characteristics, multipath propagation, user locations and beamforming radiation pattern, to effectively evaluate the EMF's spatial variation levels. Following this evaluation procedure, the impact of different user densities and distributions is analyzed in terms of PD and SAR. Results show that for DL, the peak PD increases from 6.65 to 24.92 dBm/m2 when the number of active users in the area increases from a single user to 100%. Considering the worst-case scenario, the PD exposure reaches 62% of the ICNIRP's limit. Saturation of the spatial EMF distribution occurs when the number of active DL beams is above 25%. For UL, within 5m radius of the user's location, the average E-field may increase from 2.40 to 3.98 V/m. (increment of 66%) if the number of active users in the area increases from 25% to 100%. Moreover, when 100% of the users are actively transmitting, there is only a 10% probability that the SAR may exceed 0.06 W/kg (or 3% of the ICNIRP's limit).
Open access paper: https://ijtech.eng.ui.ac.id/article/view/5928

RF-EMF EXPOSURE FOR SUB-6GHZ 5G NR MASSIVE MIMO BASE STATION

Sali A, Wali AQ, Osman AF. Evaluation of RF-EMF Exposure for sub-6GHz 5G NR Massive MIMO Base Station. 2022 IEEE 6th International Symposium on Telecommunication Technologies (ISTT), 2022, pp. 16-21, doi: 10.1109/ISTT56288.2022.9966552.

Abstract

The 5G network is intended to accommodate a significant quantity of mobile data traffic and a great number of wireless connections. It improves cost and power consumption; it offers ultra-low latency and ultra-high dependability to enable new services in various sectors. However, the general public is concerned about the possible health dangers linked with 5G equipment's Radio Frequency (RF) radiation, and numerous localities are actively lobbying to prevent 5G implementation. This research measures the maximum exposure emitted by a 5G base station operating on 3.5 GHz. Considering the transmitted power changes over time with data traffic, the analysis is based on a code selective method. Measurements were conducted at two different distances and three different times to investigate the impacts of distance and time on the level of RF-EMF radiation. The maximum radiation from the base station is 11.69 V/m, far less than the accepted limit by the ICNIRP standard.
https://ieeexplore.ieee.org/document/9966552

REALISTIC HUMAN EXPOSURE AT 3.5 GHZ AND 28 GHZ FOR DISTRIBUTED AND COLLOCATED MAMIMO IN INDOOR ENVIRONMENTS

R. Wydaeghe et al. Realistic Human Exposure at 3.5 GHz and 28 GHz for Distributed and Collocated MaMIMO in Indoor Environments using Hybrid Ray-Tracing and FDTD. IEEE Access, doi: 10.1109/ACCESS.2022.3227107.

Abstract

Realistic human downlink exposure at 3.5 and 28 GHz to electromagnetic fields is evaluated for distributed and collocated base stations using a hybrid ray-tracing/finite-difference time-domain method. For the first time, the absorbed power density is computed for distributed massive multiple-input multiple-output (DMaMIMO) 6G base stations (BS) at 28 GHz. The results are compared with 3.5 GHz 5G base stations. Computational costs are drastically increased at 28 GHz. A large analysis is realized by speed improvements and using two

configurations. In the first, exposure distributions of DMaMIMO BS show clusters of low and high exposure. These clusters disappear when results are normalized with respect to the incoming power at the user. In the second, the influence of BS to user distance in line-of-sight (LOS) and non-line-of-sight (NLOS) scenarios shows expected results. This includes a power law relationship in LOS and shadowing in NLOS. The vast majority of exposure quantities are less than 4% of the limits of the International Commission for Non-Ionizing Radiation. Basic restrictions are respected when reference quantities are set to their limits. With equal power, distributed base stations contribute 2 to 3 times less to exposure than collocated base stations. Expressed as a ratio to their limits set by ICNIRP, the basic quantities are 5 to 10 dB lower than the reference quantities. https://ieeexplore.ieee.org/document/9970725

TOWARDS OUTDOOR ELECTROMAGNETIC FIELD EXPOSURE MAPPING GENERATION USING CONDITIONAL GANS

Mallik M, Tesfay AA, Allaert B, Kassi R, Egea-Lopez E, Molina-Garcia-Pardo JM, Wiart J, Gaillot DP, Clavier L. Towards Outdoor Electromagnetic Field Exposure Mapping Generation Using Conditional GANs. Sensors (Basel). 2022 Dec 9;22(24):9643. doi: 10.3390/s22249643.

Abstract

With the ongoing fifth-generation cellular network (5G) deployment, electromagnetic field exposure has become a critical concern. However, measurements are scarce, and accurate electromagnetic field reconstruction in a geographic region remains challenging. This work proposes a conditional generative adversarial network to address this issue. The main objective is to reconstruct the electromagnetic field exposure map accurately according to the environment's topology from a few sensors located in an outdoor urban environment. The model is trained to learn and estimate the propagation characteristics of the electromagnetic field according to the topology of a given environment. In addition, the conditional generative adversarial network-based electromagnetic field mapping is compared with simple kriging. Results show that the proposed method produces accurate estimates and is a promising solution for exposure map reconstruction.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9784695/

OCCUPATIONAL HEALTH AND SAFETY: MEASUREMENT AND ANALYSIS OF THE ELECTROMAGNETIC RADIATION PRODUCED BY RADIOFREQUENCY DEVICES FOR REJUVENATION

Wei S, Zhou C, Huang L. Occupational health and safety: measurement and analysis of the electromagnetic radiation produced by radiofrequency devices for rejuvenation. Lasers Med Sci. 2022 Dec 27;38(1):25. doi: 10.1007/s10103-022-03669-y.

Abstract

With the ongoing development of cosmetic technology, many different types of radiofrequency (RF) devices are widely used for face and body rejuvenation. These, like many other high-power devices, may emit excessive electromagnetic radiation into the surrounding environment. Long-term exposure to this environment can lead to poor health outcomes; therefore, it is important to measure and analyze the electromagnetic radiation levels for the health and safety of therapists. A handheld electronic electromagnetic radiation measuring instrument was used to measure the electric and magnetic field strengths. All results were analyzed using the R software (R Core Team, 2021-02-15). We found that the monopolar and

unipolar RF devices that we measured from, in this study, could produce large amounts of electromagnetic radiofrequency emissions during operation, whereas the microneedle RF (bipolar RF) device emitted relatively lower amounts ($P < 0.01$). The strength of electromagnetic radiation is related to power and distance; it increases with power and decreases with distance. This study proved that certain RF devices for rejuvenation could cause severe electromagnetic radiofrequency pollution. The occupational health and safety of therapists require more attention, and effective protective measures need to be taken immediately.
https://pubmed.ncbi.nlm.nih.gov/36574050/

THE DOSE-DEPENDENT EFFECT OF 1.5-GHZ MICROWAVE EXPOSURE ON SPATIAL MEMORY AND THE NMDAR PATHWAY IN WISTAR RATS

Wang H, Song L, Zhao L, Wang H, Xu X, Dong J, Zhang J, Yao B, Zhao X, Peng R. The dose-dependent effect of 1.5- GHz microwave exposure on spatial memory and the NMDAR pathway in Wistar rats. Environ Sci Pollut Res Int. 2022 Dec 27:1–13. doi: 10.1007/s11356-022-24850-4.

Abstract

A certain power of microwave radiation could cause changes in the nervous, cardiovascular, and other systems of the body, and the brain was a sensitive target organ of microwave radiation injury. Studies have shown that microwaves can impair cognitive functions in humans and animals, such as learning and memory, attention, and orientation. The dose-dependent effect of microwave radiation is still unclear. Our study aimed to investigate the effects of 1.5-GHz microwaves with different average power densities on locative learning and memory abilities, hippocampal structure, and related N-methyl D-aspartate receptor (NMDAR) signalling pathway proteins in rats. A total number of 140 male Wistar rats were randomly divided into four groups: S group (sham exposure), L5 group (1.5-GHz microwaves with average power density = 5 mW/cm2), L30 group (1.5-GHz microwaves with average power density = 30 mW/cm2), and L50 group (1.5-GHz microwaves with average power density = 50 mW/cm2). Changes in spatial learning and memory, EEG activity, hippocampal structure, and NMDAR signalling pathway molecules were detected from 6 h to 28 d after microwave exposure. After exposure to 1.5-GHz microwaves, rats in the L30 and L50 groups showed impaired spatial memory, inhibited EEG activity, pyknosis and hyperchromatism of neuron nucleus, and changes in NMDAR subunits and downstream signalling molecules. In conclusion, 1.5-GHz microwaves with an average power density of 5, 30, and 50 mW/cm2 could induce spatial memory dysfunction, hippocampal structure changes, and changes in protein levels in rats, and there was a defined dose-dependent effect.
Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9792922/

WIFI RELATED RADIOFREQUENCY ELECTROMAGNETIC FIELDS PROMOTE TRANSPOSABLE ELEMENT DYSREGULATION AND GENOMIC INSTABILITY IN DROSOPHILA MELANOGASTER

Cappucci U, Casale AM, Proietti M, Marinelli F, Giuliani L, Piacentini L. WiFi Related Radiofrequency Electromagnetic Fields Promote Transposable Element Dysregulation and Genomic Instability in Drosophila melanogaster. Cells. 2022 Dec 13;11(24):4036. doi: 10.3390/cells11244036.

Abstract

Exposure to artificial radio frequency electromagnetic fields (RF-EMFs) has greatly increased in recent years, thus promoting a growing scientific and social interest in deepening the biological impact of EMFs on living organisms. The current legislation governing the exposure to RF-EMFs is based exclusively on their thermal effects, without considering the possible non-thermal adverse health effects from long term exposure to EMFs. In this study we investigated the biological non-thermal effects of low-level indoor exposure to RF-EMFs produced by WiFi wireless technologies, using Drosophila melanogaster as the model system. Flies were exposed to 2.4 GHz radiofrequency in a Transverse Electromagnetic (TEM) cell device to ensure homogenous controlled fields. Signals were continuously monitored during the experiments and regulated at non thermal levels. The results of this study demonstrate that WiFi electromagnetic radiation causes extensive heterochromatin decondensation and thus a general loss of transposable elements epigenetic silencing in both germinal and neural tissues. Moreover, our findings provide evidence that WiFi related radiofrequency electromagnetic fields can induce reactive oxygen species (ROS) accumulation, genomic instability, and behavioural abnormalities. Finally, we demonstrate that WiFi radiation can synergize with RasV12 to drive tumor progression and invasion. All together, these data indicate that radiofrequency radiation emitted from WiFi devices could exert genotoxic effects in Drosophila and set the stage to further explore the biological effects of WiFi electromagnetic radiation on living organisms.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9776602/

A NOVEL REVERBERATION CHAMBER FOR IN VITRO BIOELECTROMAGNETIC EXPERIMENTS AT 3.5 GHZ

R. Orlacchio et al.. A Novel Reverberation Chamber for In Vitro Bioelectromagnetic Experiments at 3.5 GHz. IEEE Transactions on Electromagnetic Compatibility, doi: 10.1109/TEMC.2022.3216045.

Abstract

In this article, a mode-stirred reverberation chamber (RC) was designed and proposed for the first time as a cell culture incubator for in vitro electromagnetic waves exposure of adherent cells in tissue culture plates (TCPs). Typical cell incubators require specific conditions, such as temperature of 37 °C and humidity rate of 95%, which are challenging conditions for an RC. The chamber was characterized as an RC through an innovative experimental methodology based on the measurements of the S11 parameter of the emitting antenna. The proposed RC is adapted for in vitro bioelectromagnetic experiments for simultaneous exposure of up to 10 TCPs under highly homogeneous exposure conditions at 3.5 GHz, i.e., the mid-frequency band of the 5G telecommunication networks. Experimental results showed that the specific absorption rate (SAR) in the exposed samples extracted from temperature measurements was similar (an acceptable maximum variation lower than 30% was observed) in reason of the

homogeneity and the uniformity of the field within the chamber. Specifically, measured SAR values were around 1.5 and 1 W/kg per 1 W incident, in 6-well or 96-well plates used for biological exposure, respectively. To validate our system, numerical simulations were performed. Overall, we showed that experimental and numerical SARs are in good agreement with differences <30% considering the standard deviation.
https://ieeexplore.ieee.org/document/9975146

THERMAL EFFECT ESTIMATION OF SMARTPHONE VIRTUAL REALITY HEADSETS ON HUMAN EYE BY FINITE ELEMENT METHOD

Uluaydin N, Şeker S. (2022). Thermal Effect Estimation of Smartphone Virtual Reality Headsets on Human Eye by Finite Element Method. Sakarya University Journal of Science, 26(3):590-599. doi:10.16984/saufenbilder.972989.

Abstract

Smartphones (SP) terminals are becoming the most popular media for virtual reality (VR) and augmented reality (AR) effects with their central processing unit (CPU) and video capabilities. Simple VR headsets with reasonable costs can host smartphones, and they can together be used for many different applications. But with the outbreak of Covid-19 pandemic, their usage has become essential for many people working from their homes. VR and AR capabilities provide a much richer experience for entertainment, gaming, and video conferencing.

The increasing popularity of 3D virtual worlds add up to this usage. On the technology side, multi-radio connectivity is supported both on terminal and network side. A certain risk may arise when using SP VR headsets for such applications requiring a broadband Internet connectivity. SPs with multi-radio connectivity feature may elevate specific absorption rate (SAR) values in those cases. The smartphone used for VR and AR applications is positioned in front of the eyes; and there is very limited ventilation in VR/AR headsets. Authors' model aims simulate these exposure scenarios in 4G and 5G mobile telecommunication frequencies by finite element method (FEM); and, possible thermal and non-thermal risks of related electromagnetic (EM) radiation on human eye according to the outputs of the model are discussed.

Open access paper: http://www.saujs.sakarya.edu.tr/tr/pub/issue/70993/972989

MACHINE LEARNING MODELS FOR PREDICTING BREAST CANCER RISK IN WOMEN EXPOSED TO BLUE LIGHT FROM DIGITAL SCREENS

Mortazavi, S. A., Tahmasebi, S., Parsaei, H., Taleie, A., Faraz, M., Rezaianzadeh, A., Zamani, A., Zamani, A., Mortazavi, S. M. J. (2022). Machine Learning Models for Predicting Breast Cancer Risk in Women Exposed to Blue Light from Digital Screens. Journal of Biomedical Physics and Engineering, 12(6), 637-644. doi: 10.31661/jbpe.v0i0.2105-1341.

Abstract

Background: Nowadays, there is a growing global concern over rapidly increasing screen time (smartphones, tablets, and computers). An accumulating body of evidence indicates that prolonged exposure to short- wavelength visible light (blue component) emitted from digital screens may cause cancer. The application of machine learning (ML) methods has significantly improved the accuracy of predictions in fields such as cancer susceptibility, recurrence, and survival.

Objective: To develop an ML model for predicting the risk of breast cancer in women via several parameters related to exposure to ionizing and non-ionizing radiation.

Material and Methods: In this analytical study, three ML models Random Forest (RF), Support Vector Machine (SVM), and Multi-Layer Perceptron Neural Network (MLPNN) were used to analyze data collected from 603 cases, including 309 breast cancer cases and 294 gender and age-matched controls. Standard face-to-face interviews were performed using a standard questionnaire for data collection.

Results: The examined models RF, SVM, and MLPNN performed well for correctly classifying cases with breast cancer and the healthy ones (mean sensitivity> 97.2%, mean specificity >96.4%, and average accuracy >97.1%).

Conclusion: Machine learning models can be used to effectively predict the risk of breast cancer via the history of exposure to ionizing and non-ionizing radiation (including blue light and screen time issues) parameters. The performance of the developed methods is encouraging; nevertheless, further investigation is required to confirm that machine learning techniques can diagnose breast cancer with relatively high accuracies automatically.
Open access paper: https://jbpe.sums.ac.ir/article_48176.html

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EVALUATION OF ELECTROMAGNETIC FIELDS IN HUMAN BODY EXPOSED TO INVERTER OF PURE ELECTRIC VEHICLE

Dong X, Sun W, Lu M. Evaluation of electromagnetic fields in human body exposed to inverter of pure electric vehicle. Radiat Prot Dosimetry. 2022 Dec 22:ncac269. doi: 10.1093/rpd/ncac269.

Abstract

On the basis of the basic principle of electromagnetic dosimetry, the paper studies the electromagnetic exposure of a passenger's body to a compound electromagnetic field caused by the combined action of DC and AC bus currents of a pure electric vehicle inverter. By building an electromagnetic model of a pure electric vehicle body, adult human body and inverter, the finite element method is used to calculate the magnetic induction intensity(|B|), induced electric field intensity(|E|) and induced current density(|J|) of the compound electromagnetic field to the human trunk and central nervous system in the driver and front seat passenger. The numerical results are compared with the exposure limits defined by the International Commission on Non- Ionizing Radiation Protection (ICNIRP). The fields are well below the safe exposure limits defined by ICNIRP.
https://pubmed.ncbi.nlm.nih.gov/36562627/

In vivo genotoxicity of high-intensity intermediate frequency magnetic fields in somatic cells and germ cells

Ohtani S, Ushiyama A, Wada K, Suzuki Y, Hattori K. In vivo genotoxicity of high-intensity intermediate frequency magnetic fields in somatic cells and germ cells. J Radiat Res. 2022 Dec 29:rrac081. doi: 10.1093/jrr/rrac081.

Abstract

Intermediate frequency magnetic fields (IF-MFs) at ~85 kHz are one of the components of wireless power transfer (WPT) systems. However, the available data needed for the assessment of the safety of organisms from IF-MF exposure are scarce. Thus, there is an imminent need to accumulate evidence-based assessment data. In particular, if humans are exposed to IF-MF due to an accident or trouble, they are at increased risk of being exposed to high-intensity IF-MF within a short period. The already existing exposure system was improved to a system that could intermittently expose animals at 3 s intervals. This system allows the exposure of a mouse to high-intensity IF-MF (frequency: 82.3 kHz; induced electric field: 87 V/m, which was 3.8 times the basic restriction level for occupational exposure in the ICNIRP guideline), while regulating the heat generated by the coil. In vivo genotoxicity after IF-MF exposure was assessed using micronucleus (MN) test, Pig-a assay, and gpt assay. The results of MN test and Pig-a assay in hematopoietic cells revealed that neither the reticulocytes nor the mature erythrocytes exhibited significant increases in the IF-MF-exposed group compared with that in the sham-exposed group. In germ cells, MN test and gpt assay outcomes showed that IF-MF exposure did not cause any genetic or chromosomal abnormality. Based on these data, there was no genotoxic effect of our set IF-MF exposure on somatic and germ cells. These findings can contribute to the widespread use of WPT systems as effective data of IF-MF safety assessment.

https://pubmed.ncbi.nlm.nih.gov/36579461/

BIOLOGICAL EFFECTS OF ROTATING MAGNETIC FIELD: A REVIEW FROM 1969 TO 2021

Wei Y, Wang X. Prog Biophys Mol Biol. 2022 Dec 24:S0079-6107(22)00134-1. doi: 10.1016/j.pbiomolbio.2022.12.006.

Abstract

As one of the common variable magnetic fields, rotating magnetic field (RMF) plays a crucial role in modern human society. The biological effects of RMF have been studied for over half a century, and various results have been discovered. Several reports have shown that RMF can inhibit the growth of various types of cancer cells in vitro and in vivo and improve clinical symptoms of patients with advanced cancer. It can also affect endogenous opioid systems and rhythm in central nerve systems, promote nerve regeneration and regulate neural electrophysiological activity in the human brain. In addition, RMF can influence the growth and metabolic activity of some microorganisms, alter the properties of fermentation products, inhibit the growth of some harmful bacteria and increase the susceptibility of antibiotic-resistant bacteria to common antibiotics. Besides, there are other biological effects of RMF on blood, bone, prenatal exposure, enzyme activity, immune function, aging, parasite, endocrine, wound healing, and plants. These discoveries demonstrate that RMF have great application potential in health care, medical treatment, fermentation engineering, and even agriculture.

However, in some cases like pregnancy, RMF exposure may need to be avoided. Finally, the specific mechanisms of RMF's biological effects remain unrevealed, despite various hypotheses and theories. It does not prevent us from using it for our good.
https://pubmed.ncbi.nlm.nih.gov/36574882/

LOW-LEVEL EMF EFFECTS ON WILDLIFE AND PLANTS: WHAT RESEARCH TELLS US ABOUT AN ECOSYSTEM APPROACH

Levitt BB, Lai HC, Manville AM II. (2022) Low-level EMF effects on wildlife and plants: What research tells us about an ecosystem approach. Front. Public Health 10:1000840. doi: 10.3389/fpubh.2022.1000840.

Abstract

There is enough evidence to indicate we may be damaging non-human species at ecosystem and biosphere levels across all taxa from rising background levels of anthropogenic non-ionizing electromagnetic fields (EMF) from 0 Hz to 300 GHz. The focus of this Perspective paper is on the unique physiology of non-human species, their extraordinary sensitivity to both natural and anthropogenic EMF, and the likelihood that artificial EMF in the static, extremely low frequency (ELF) and radiofrequency (RF) ranges of the non-ionizing electromagnetic spectrum are capable at very low intensities of adversely affecting both fauna and flora in all species studied. Any existing exposure standards are for humans only; wildlife is unprotected, including within the safety margins of existing guidelines, which are inappropriate for trans-species sensitivities and different non-human physiology. Mechanistic, genotoxic, and potential ecosystem effects are discussed.

Excerpt

Radiofrequency radiation is a form of energetic air pollution and should be regulated as such (25). U.S. law (130) [42 USC § 7602 (g)] defines air pollution as:

“The term “air pollutant” means any air pollution agent or combination of such agents, including any physical, chemical, biological, radioactive (including source material, special nuclear material, and byproduct material) substance or matter which is emitted into or otherwise enters the ambient air. Such term includes any precursors to the formation of any air pollutant, to the extent the Administrator has identified such precursor or precursors for the particular purpose for which the term “air pollutant” is used.”

Unlike classic chemical toxicology pollutants in which a culprit can typically be identified and quantified, RFR may function as a “process” pollutant in the air not unlike how endocrine disruptors function in food and water in which the stressor causes a cascade of unpredictable systemic effects. The stimulus in the RFR analogy would be physical/energetic rather than chemical.

Long-term chronic low-level EMF exposure guidelines, which do not now exist, should be set accordingly for wildlife; mitigation techniques where possible should be developed; full environmental reviews should be conducted prior to the licensing/buildout of major new technologies like 5G; and environmental laws/regulations should be strictly enforced (25). We have a long over-due obligation to consider potential consequences to other species from our

current unchecked technophoria—an obligation we have thus far not considered before species go extinct. In the views of these authors, the evidence requiring action is clear.
Open access paper: https://www.frontiersin.org/articles/10.3389/fpubh.2022.1000840

BIOLOGICAL EFFECTS OF RADIOFREQUENCY ELECTROMAGNETIC FIELDS ABOVE 100 MHZ ON FAUNA AND FLORA: WORKSHOP REPORT

Pophof B, Henschenmacher B, Kattnig DR, Kuhne J, Vian A, Ziegelberger G. Biological Effects of Radiofrequency Electromagnetic Fields above 100 MHz on Fauna and Flora: Workshop Report. Health Physics. November 4, 2022. doi: 10.1097/HP.0000000000001625.

Abstract

This report summarizes the effects of anthropogenic radiofrequency electromagnetic fields with frequencies above 100 MHz on flora and fauna presented at an international workshop held on 5–7 November 2019 in Munich, Germany. Anthropogenic radiofrequency electromagnetic fields at these frequencies are commonplace; e.g., originating from transmitters used for terrestrial radio and TV broadcasting, mobile communication, wireless internet networks, and radar technologies. The effects of these radiofrequency fields on flora, fauna, and ecosystems are not well studied. For high frequencies exceeding 100 MHz, the only scientifically established action mechanism in organisms is the conversion of electromagnetic into thermal energy. In accordance with that, no proven scientific evidence of adverse effects in animals or plants under realistic environmental conditions has yet been identified from exposure to low-level anthropogenic radiofrequency fields in this frequency range. Because appropriate field studies are scarce, further studies on plants and animals are recommended.

Open access paper:
https://journals.lww.com/healthphysics/Fulltext/9900/Biological_Effects_of_Radiofrequency.47.aspx

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MOBILE PHONE AND BASE STATIONS: RADIATION AND ITS EFFECTS ON HUMAN HEALTH AND ENVIRONMENT: A REVIEW

Jayaraju Nadimikeri, M. Pramod Kumar, G. Sreenivasulu, T. Lakshmi Prasad, B. Lakshmanna, K. Nagalaksmi, M. Madakka. Mobile phone and base stations: Radiation and its effects on human health and environment: A Review. Sustainable Technology and Entrepreneurship. 2022. doi: 10.1016/j.stae.2022.100031.

Abstract

A review of the impact of mobile phone and base station radiation on human health and the environment has been presented here. Cell phone is an important invention in human history that has revolutionized people's lifestyles. As mobile phones have become an integral part of human daily routine, the quality of life around the world has improved significantly. However, concerns about the exposure of people, flora and fauna to radio frequencies are not new. The satisfaction and convenience derived from the use of cellular phones is threatened by claims that the radiation emitted by the devices has unfavorable impacts on human health. The effects of radiation may be classified into non-thermal and thermal. Thermal effects are similar to those of cooking in a microwave oven. The non-thermal effects are not properly defined, but it is been learnt that these effects are three to four times more hazardous than the thermal, which remains controversial. A brief picture of the Indian scenario of cell phone

industry and the number of mobile towers in India was discussed. The effects of radiation emitted from cell phones and base stations on wildlife, humans and the environment were summarized with suitable examples and studies conducted by various voluntary organizations.

Conclusion

This study reports and summarises some research done by different institutions and organisations. The work was motivated by the fact that the public is concerned about the threat posed by the use of mobile phones. The use of mobile phones is increasing tremendously day by day, but most people are not aware of the impact of mobile phones on human health. However, operators are competing with each other to attract more customers and are building mobile towers in every possible corner of the country to expand their own network coverage, even though the operators claim there are no health concerns. Some studies (Maregu, N. 2016; Larik et al., 2016; Asl, et al., 2019; Singh et al., 2020;) report that there is a strong correlation between mobile phone radiation to the major health problems in people. However, some studies report that there is no impact on non- ionisation radiation exposure from mobile phones and base stations (Meena et al., 2016; Schüz et al 2006; Schoemaker et al, 2005). On the other hand, some reports suggest that prolonged use of cell phones and exposure to mobile and base stations leads to abnormal mental disorders, sleep disturbances, concentration difficulties, headaches, irritability, dizziness and hypertension (Loenn et al., 2004). Nevertheless, everyone has observed a sharp decline in the population of house sparrows (passer domesticus), which can be attributed, among other things, to radiation from base stations. Therefore, it is high time to conduct multidisciplinary studies to decipher the effects of radiation from mobile phones and cell towers on humans and the environment. It is also imperative that policy makers and executive bodies enforce stringent radiation norms.

Open access paper: https://www.sciencedirect.com/science/article/pii/S2773032822000311

COMMENT ON "5G MOBILE NETWORKS AND HEALTH-A STATE-OF-THE-SCIENCE REVIEW OF THE RESEARCH INTO LOW-LEVEL RF FIELDS ABOVE 6 GHZ" BY KARIPIDIS ET AL.

Weller, S., May, M., McCredden, J. et al. Comment on "5G mobile networks and health-a state-of-the-science review of the research into low-level RF fields above 6 GHz" by Karipidis et al.. J Expo Sci Environ Epidemiol (2022). https://doi.org/10.1038/s41370-022-00497-8.

Conclusion

In our opinion, the Karipidis review provides insufficient evidence of safety, which is being used by Industry [3] as justification for the planned densification and ubiquitous use of radiofrequencies >6 GHz as part of the 5G rollout. However, we concur with Karipidis that future experimental studies "should improve the experimental design" and "epidemiological research should continue to monitor long-term health effects in the population related to wireless telecommunications".

Data generated and analysed for the production of this comment article is freely available for download from the Oceania Radiofrequency Scientific Advisory (ORSAA) website at the following address: https://www.orsaa.org/5g-review-supplementary-material.html.

Open access paper: https://rdcu.be/c0teu

THE ASSOCIATION BETWEEN SELF-REPORTED MOBILE PHONE USAGE WITH BLOOD PRESSURE AND HEART RATE: EVIDENCE FROM A CROSS-SECTIONAL STUDY

Amiri, F., Moradinazar, M., Moludi, J. et al. The association between self-reported mobile phone usage with blood pressure and heart rate: evidence from a cross-sectional study. BMC Public Health 22, 2031 (2022). doi:10.1186/s12889-022-14458-1.

Abstract

Background With the advancement of technology, the rate of access and use of mobile phones in different communities has increased significantly. Mobile phones emit electromagnetic waves and therefore excessive use of them may have harmful effects on physical and mental health and especially on the cardiovascular system. This study aimed to investigate the association between self-reported mobile phone use duration and blood pressure and heart rate (HR) using data from Ravansar non-communicable diseases (RaNCD) cohort study.

Methods The present cross-sectional study was performed using the data of 8905 out of 10,065 participants in the RaNCD study in Iran. According to the mean self-reported duration of mobile phone usage (min/day) over the previous 12 months, all users were divided into four groups. The first and fourth groups had the least and most time using mobile phones respectively. The relationship between blood pressure and the duration of mobile phone use was determined using univariate and multiple linear regression.

Results Of 8905 participants aged 35–65 years, 1515 (17.0%) of them didn't use mobile phones. The minimum, maximum, and mean duration of self-reported mobile phone use between users were 3.4, 50.4, and 19.5 min/day, respectively. A decrease in women's systolic and diastolic blood pressure (SBP and DBP) and HR was observed by increasing the duration of mobile phone use. With adjustment for effective confounding factors, there was a significant negative association between SBP [-2.52 (-4.11, -0.94)], DBP [-1.86 (-2.83, -0.89)], and duration of mobile use.

Conclusion In this study, a significant decreasing trend was found between SBP, DBP, and HR and higher mobile phone usage in women. Based on regression analysis, SBP, DBP, and duration of mobile phone use were associated negatively in those who used their phones for at least 8 h.

Conclusion

The findings of the present study revealed that mobile phone use duration significantly affect BP just in females. After adjustment for all confounding factors, in whole population, SBP and DBP, in individuals who used their mobile phone more than 8 h/day (Q2-Q4), were significantly decreased in all three models. In contrast, after adjustment for all confounding factors, there was no significant association between mobile phone use duration and HR in all adjusted models. Since the association between mobile phone use duration and HR was weak for women and absent for men, perhaps this was just a chance finding that needs to be investigated further.

Open access paper: https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-022-14458-1

SWIPE RIGHT ON MALE INFERTILITY: EFFECT OF CELL PHONE RADIATION ON SPERM MOTILITY

Chu KY, Khodamoradi K, Dullea A, Ramasamy R. Swipe Right on Male Infertility: Effect of cell phone radiation on sperm motility. Fertility and Sterility. 118(5 Suppl):e38-e39. 2022. doi:10.1016/j.fertnstert.2022.09.288.

Abstract

Background Over the past decade, the relationship between humans and their smartphones have been marked with stark symbiosis. The advent of Bluetooth earbuds has presumably prolonged the amount of time the cell phone resides in the trouser pockets of men. This places the smartphone and its respective radiofrequency - electromagnetic radiation (RF-EMR) near the testicles. RF-EMR has been postulated to increase oxidative stress and induce free radical formation.

Objective We hypothesized that RF-EMR from cell phones has deleterious effects on sperm parameters, though these effects can be mitigated with solid mediums or distance.

Materials and Methods We evaluated the impact of current generation smartphone, in talk mode, as the RF- EMR source. We certified the exposure to the specimen using calibrated RF-EMR meter (validated in previous studies). Initially, we studied the impact of RF-EMR on sperm motility and viability from fertile, normozoospermic men, between the ages of 25-35 years old by exposing their semen in an in vitro study over an 8-hour duration. We then determined whether using a cell phone case and increasing distance from semen sample would make a difference in outcomes. Statistical differences were analyzed using paired t student test for comparisons between two sub-groups where $p<0.05$ was set as significant.

Results At 6 hours after exposure, we identified a decrease in sperm motility and viability in samples exposed to RF-EMR as compared to those samples that were not from fertile controls. With the addition of the case, we noted a smaller impact on total sperm motility and viability ($p = 0.01$, $p = 0.01$) as compared to direct RF-EMR exposure. In fact, moving the cell phone away by 3 inches represented the best mitigation strategy to deleterious effects on sperm motility and viability. Interestingly, when the phones were turned on in the talk- mode, most detrimental effects on sperm motility were identified.

Conclusions In this pilot study, we observe that the sperm parameters of motility and vitality are impacted with RF-EMR exposure from cell phones. Precautionary measures such as physical shields and increased distance from the scrotum dampened the effects of RF-EMR. Further in vivo research on the true impact of cell phone radiation on male fertility potential is warranted. https://www.sciencedirect.com/science/article/pii/S0015028222017095

ELECTROMAGNETIC RADIATIONS ON THE FUNCTIONAL POTENTIAL OF SPERMATOZOA

Ranjitsingh AJA., Elizabeth MM., Dhasarathan P, Athinarayanan G. Electromagnetic radiations on the functional potential of spermatozoa. Res. J. Biotech. 17(10);12-17. doi:10.25303/1710rjbt12017; (2022).

Abstract

The growing exposure to digital communication system and tools leads to radiation toxicity to the users. Unaware of the safety measures, even a kid at the age of one starts operating digital gadgets emitting radio frequency-electromagnetic radiations. Radiations from mobile phones, laptops, note pad, Wi-Fi or other devices are reported to be harmful beyond the permissible limit. So there is a growing concern for the overall health, reproductive and hormonal functions. Experimental studies were conducted by using a Wi-Fi network active laptop and live spermatozoa. The exposure of sperms to the source of EMF showed that the activity of the live sperms got reduced and mortality was observed depending on the exposure duration and the distance from EMF sources.

After 5h of exposure to RF-EMF source, the semen quality changed when compared with control. The vitality of sperm in the control was 95±1.0 after 2 hr and it was reduced to 60±1.5 percent at a distance of 1cm and 55±2.2 percent at a distance of 10 cm. After 5 hour exposure, the vitality was reduced to 63±1.86 at 1 cm distance and 70± 1.42 at 10 cm distance. The reduction in vitality of sperm after exposure to RFEMF source for 2 hour was 35% at 1cm and 40% at 10cm distance.

Open access paper:
https://worldresearchersassociations.com/Archives/RJBT/Vol(17)2022//October%202022/Electromagnetic%20radiations%20on%20the%20functional%20potential%20of%20spermatozoa.pdf

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WHY THE PSYCHOGENIC OR PSYCHOSOMATIC THEORIES FOR ELECTROHYPERSENSITIVITY CAUSALITY SHOULD BE ABANDONED, BUT NOT THE HYPOTHESIS OF A NOCEBO-ASSOCIATED SYMPTOM FORMATION CAUSED BY EMF CONDITIONING IN SOME PATIENTS

Belpomme D, Irigaray P. Why the psychogenic or psychosomatic theories for electrohypersensitivity causality should be abandoned, but not the hypothesis of a nocebo-associated symptom formation caused by electromagnetic fields conditioning in some patients. Environ Res. 2022;114839. doi:10.1016/j.envres.2022.114839

Excerpt

In summary, the Pitron et al. response to the editor is not based on appropriate and sound experimental data, but rather on a general unproved psychogenic somatic theory that posits a nocebo effect as the cause of EHS and/or MCS. This should be abandoned–although it is possible that after conditioning by real EMF stimuli the subsequent role of a nocebo process, a nocebo genesis may account for the formation of some (not all) symptoms. Contrary to Pitron et al.'s nocebo claim, we recall that many years ago, similar psychogenic or psychosomatic theories accounting for the genesis of tuberculosis arose, but were abandoned as soon as the causal role of the Koch's bacillus was discovered (Barberis et al., 2017); and this was also the case more recently with autism, due to the discovery of its environmental causal origin (Volk et al., 2022).

Consequently, contrary to Pitron et al.'s unsupported claim (Belpomme and Irigaray, 2021) there is sufficient available scientific evidence to strongly recommend measures against the current unrestricted electromagnetic pollution, via application of the precautionary principle, to protect people, particularly the most vulnerable such as pregnant women, infants and children, who have been shown to be more susceptible and sensitive to anthropogenic EMFs. https://pubmed.ncbi.nlm.nih.gov/36423669/

RF EXPOSURE FROM TEN 5G BEAMFORMING CELL TOWERS (3.6 GHZ BAND) IN GERMANY

Kopacz T, Bornkessel C, Wuschek M. Consideration of current mobile phone antenna technology when determining HF-EMF exposure - project 3619S82463. Federal Office for Radiation Protection (BfS). Nov-2022. Report number(s): BfS-RESFOR-208/22. URN(s): urn:nbn:de:0221-2022112435660. (The report is in German with an English-language executive summary.)

Abstract (Google translation)

This research project deals with the metrological recording and analysis of immissions from 5G base stations with beamforming antennas in the 3.6 GHz band. As a basis, measurement methods for determining current, typical and maximum possible immissions were proposed, which suitably take into account the time-varying radiation behavior of the antennas. The maximum possible immissions can be determined either by extrapolation based on the difference in antenna gain between traffic and broadcast beams at the measuring point or by direct measurement when the maximum immission is provoked using a 5G terminal device.

Immission measurements at 100 systematically selected measuring points in the vicinity of ten 5G beamforming base stations in the 3.6 GHz band resulted in maximum immissions between 0.2% (0.15 V/m) and 28.9% (17.6 V/m m) the field strength limit of the 26th BImSchV (median 4.7% or 2.9 V/m). The instantaneous immissions without provoked traffic were between 0.04% (0.03 V/m) and 1.1% (0.67 V/m) of the field strength limit value (median 0.08% or 0.05 V/m) and the emissions during typical use (ARD live stream) are only slightly higher, between 0.04% (0.03 V/m) and 1.3% (0.8 V/m) of the field strength limit value (median 0.2% or 0.12V/m). The visibility conditions between the place of immission and the 5G antenna have a major influence on the size of the immission, since significant attenuation also occurs in the 3.6 GHz band due to vegetation. The dependence on the vertical angle between the point of immission and the antenna observed in GSM, UMTS and LTE base stations has changed in the 5G beamforming base stations examined in such a way that the immissions are no longer highest at small but at larger vertical angles. len. If the beam does not act at the point of immission, but is shifted azimuthally or radially by a few tens of meters in the cell, the measurements carried out here showed an average immission reduction of 7.5 dB compared to a direct alignment of the beam to the point of immission.

Long-term measurements showed that users were only active sporadically at the time of the measurements. Even with targeted provoked typical use, the 6-minute mean value of the field strength at most points could only be significantly raised above the detection limit of the measuring device by downloading a large file. Immission peaks were usually very limited in time.

Open access paper: https://doris.bfs.de/jspui/handle/urn:nbn:de:0221-2022112435660

5G ELECTRIC FIELDS STRENGTH WITH SOFTWARE DEFINED RADIOS

Minucci F. et al. 5G Electric Fields Strength With Software Defined Radios. IEEE Open Journal of the Communications Society, 2022, doi: 10.1109/OJCOMS.2022.3222537.

Abstract

The effect of electromagnetic radiation on public health is a recurring topic in the societal and political discourse, peaking with the introduction of every new generation of cellular technology. With the introduction of 5G, promising high peak download speeds as well as high-power beams, there is a need to revisit traditional measurement approaches. ICNIRP, a.k.a the International Committee on Non-Ionising Radiation Protection, offers a useful guideline to evaluate the electromagnetic field exposure of living tissues and provides some limits to keep exposure well below the threshold where it is considered harmful. However, modern packet radio technologies such as 5G or Wi-Fi are different from old broadcasting technologies. They deliver high power in very short bursts, spread over a wide band, thus increasing the difficulty of measuring electric fields with traditional instruments, such as spectrum analyzers. In addition, 5G promises a high spatial focusing performance, which means that the field can vary significantly even in a small area. Hence, measurements with a higher spatial density than we can achieve with expensive and bulky spectrum analyzers are urgently needed. Software-defined radios (SDRs), as a size-and cost-efficient alternative, can be used to capture signals in the time domain and thus increase measurement accuracy. However, software-defined radios are not designed to be used as RF power meters. They require accurate calibration and data analysis to ensure the measured power is correct. The aim of this work is to provide a general framework to calibrate SDRs, enabling them to measure RF power and extract the corresponding electric field value. Subsequently, the influence of the SDR parameters on the accuracy of the electric field measurement is investigated. To assess the performance of the proposed calibration framework in a real-life scenario, we rely on our private 5G network with a calibrated SDR to measure the RF power from a 5G network. Our measurements show that the average electric field exposure of 5G networks is well below 1 V/m.

Excerpt

The electric field calculation based on our 5G measurements is presented in Table 3. As expected, the electric field is stronger in positions 1 and 6 from Fig. 10, which are next to the UE. In all other positions, the electric fields are considerably lower. The average electric field values are never above 0.6 V/m. However, the electric field for a single transmission from the UE can peak at 40.82 V/m when measured with a near-field probe. Peaks from the base station, on the other hand, never surpassed 2.084 V/m. Measurements performed with two devices do not show any significant change in the electric field value generated by the base station, which is the focus of this research work. One important outcome of this measurement is that, while the regulator is focused on limiting the power of downlink transmission, the greatest contribution to RF exposure on people comes from the UE itself, similarly to what was found in [37]. Another important aspect to consider is that our results are in line with what was measured in [29]. This means that a low-cost SDR based system can be effectively employed for this kind of measurement.

https://ieeexploreieeeorg.libproxy.berkeley.edu/stamp/stamp.jsp?tp=&arnumber=9955380&isnumber=8901158

IMPACT OF ELECTROMAGNETIC RADIATION OF 4G/5G BASE STATIONS ON MEDICAL SHORT-RANGE DEVICES IN URBAN AREA

A. Svistunou, V. Mordachev, E. Sinkevich, M. Ye, A. Dubovik and I. Shakinka. 2022 International Symposium on Electromagnetic Compatibility – EMC Europe, 2022, pp. 537-542, doi: 10.1109/EMCEurope51680.2022.9901031.

Abstract

The impact of electromagnetic radiation created by micro base stations of 4G/5G cellular networks on receivers of medical short-range devices of different systems (capsule endoscopy system, body area network system, and active implant system) located inside buildings is analyzed for urban area. The analysis is made by the use of computer simulation involving the multipath radiowave propagation model which takes into account outdoor- to-indoor propagation. To perform the simulation, a 3D model of a fragment of urban area containing buildings of a height from 6 m to 60 m is developed. The integrated interference margin is used as a criterion of electromagnetic compatibility. Results of the analysis show that 4G/5G base stations can create the interference to all considered types of medical short-range devices in cases when emitters are located outside buildings and receptors are located inside buildings. In order to achieve electromagnetic compatibility between these base stations and considered medical systems, recommendations on reducing of levels of electromagnetic interference are given. Results of this research can be used to ensure safe operation of 4G/5G base stations with respect to vital medical devices.
https://ieeexplore.ieee.org/document/9901031

Conclusions

As follows from the obtained results, LTE BS and 5G BS located outside buildings can potentially create interference to all considered types of MD SRDs located inside buildings. Compliance with the requirements of standards [2]-[8] does not guarantee the absence of interference to MD SRDs. Therefore, we advise the following measures to reduce the risk of interference to MD SRD operation: 1) to set more stringent requirements on susceptibility characteristics of the MD SRD receivers in frequency bands of BS operation, as well as on spurious emission of BS transmitters in frequency bands of MD SRD operation; 2) to use additional filters in order to decrease the level of spurious emissions of BS transmitters in MD SRD frequency bands; 3) to locate BS antennas in a way that ensures the absence of the line-of-sight irradiation of hospital buildings; 4) to locate MD SRD in rooms situated on the ground floor; 5) to locate MD SRD far from windows of the room.

In this work, the worst case models of emission spectra and susceptibility characteristics in the frequency domain are employed (the upper envelope of a spectrum and the lower envelope of a susceptibility characteristic). Therefore, the calculated values of the EMC criterion are pessimistic, i.e., these values concern the worst situation. The authors intend to verify the obtained results by experiments in order to define more precisely the restrictions needed to ensure the safe use of 4G/5G BS equipment.

The results of this work can be used in the field of standardization for improving standards intended to ensure the EMC between considered equipment, as well as in the field of design/upgrade/deployment of mobile communication systems for the diagnostics of intersystem EMC between 4G/5G BS and medical devices.

ANALYSES OF SOME CALL FACTORS AFFECTING SAR LEVELS OF GSM MOBILE PHONES USED IN GHANA

Osei S, Amoako JK, Sam F, Onyekwere P, Kudozia RY. ANALYSES OF SOME CALL FACTORS AFFECTING SAR LEVELS OF GSM MOBILE PHONES USED IN GHANA. Radiat Prot Dosimetry. 2022 Nov 1:ncac206. doi: 10.1093/rpd/ncac206.

Abstract

In response to mounting radiofrequency health concerns, this study was constituted to provide critical scientific data and assess any potential exposure from global system for mobile communication mobile phones. Specific absorption rate (SAR) from phones approved by the regulator and untested/unapproved phones were measured with a ComoSAR system. The maximum 10 g SAR (0.51 W/kg) and 1 g SAR (0.99 W/kg) measured were 25 and 62% of the International Commission on Non-Ionizing Radiation Protection and Federal Communication Commission limits, respectively. The approved phone produced statistically significant higher SAR values relative to the untested phone. SAR values of the right ear were relatively higher. All maximum SAR values were recorded on the right ear. The regulatory approval status of the phone, phone's orientation to the head, operating frequency channel and in which ear (right or left) the phone is used influenced the SAR measured. The SAR values of the approved phone compared favourably with similar studies while the unapproved phone does not. https://pubmed.ncbi.nlm.nih.gov/36321330/

Conclusions

The study has revealed that, the regulatory approval status of the GSM mobile phone, the head side of the ear (left or right ear), the orientation of the phone when placed on the ear (left or tilt) and the transmitting frequency channel deployed during phone calls do have a significant impact on the SAR levels of the mobile phone. The SAR levels generally complied with the ICNIRP 10 g SAR basic restriction and the FCC 1 g SAR limit. The highest measured 10 g SAR of 0.51 W/kg is 26% of the ICNIRP basic restriction, and the maximum 1 g SAR of 0.99 W/kg is 62% of the FCC limit. These results generally agree with those recorded in Morga et al.(14) but are higher than that of Mahfouz et al.(16). The 1 g SAR at all times exceeded its counterpart 10 g SAR at all reference phone positions as its evaluation involved averaging over 1 g volume of tissue as compared to averaging over 10 g volume of the tissue for the 10 g SAR.

SAR levels of the approved phone were statistically significantly higher compared to the unapproved phone at all reference phone positions with the exception of RCL position. Possible reasons included the difference in phone antenna type, different antenna positions in the mobile phone and also the different brands of phones used. The right ear produced higher SAR relative to the left ear, which may be due to the differences in positioning of the phone antenna relative to the ear when used at the right ear and left ear. Specifically, all maximum SAR values occurred at the right ear. HEP SAR were relatively lower than the approved phone SAR even though agreeing with that of SAR unapproved phones. The approved phone measured SAR agreed with similar works done elsewhere but not in the case of the unapproved.

ELECTROMAGNETIC FIELDS EXPOSURE ASSESSMENT IN EUROPE UTILIZING PUBLICLY AVAILABLE DATA

Iakovidis S, Apostolidis C, Manassas A, Samaras T. Electromagnetic Fields Exposure Assessment in Europe Utilizing Publicly Available Data. Sensors (Basel). 2022 Nov 4;22(21):8481. doi: 10.3390/s22218481.

Abstract

The ever-increasing use of wireless communication systems during the last few decades has raised concerns about the potential health effects of electromagnetic fields (EMFs) on humans. Safety limits and exposure assessment methods were developed and are regularly updated to mitigate health risks. Continuous radiofrequency EMF monitoring networks and in situ measurement campaigns provide useful information about environmental EMF levels and their variations over time and in different microenvironments. In this study, published data from the five largest monitoring networks and from two extensive in situ measurement campaigns in different European countries were gathered and processed. Median electric field values for monitoring networks across different countries lay in the interval of 0.67-1.51 V/m. The median electric field value across different microenvironments, as evaluated from in situ measurements, varied from 0.10 V/m to 1.42 V/m. The differences between networks were identified and mainly attributed to variations in population density. No significant trends in the temporal evolution of EMF levels were observed. The influences of parameters such as population density, type of microenvironment, and height of measurement on EMF levels were investigated.

Excerpt

Table 4 and Table 5 show that there are cases where the lowest ICNIRP reference level (i.e., 27.7 V/m) [1] was exceeded. In these cases, a frequency-selective measurement and extrapolation to maximum traffic was performed [41]. In those cases where extrapolated E-field levels exceeded the lowest ICNIRP reference level, appropriate actions (shutdown or power reduction in relative transmitters) were taken [33,46,47], measurements were repeated, and finally, compliance was demonstrated.

Conclusions

The continuous monitoring of RF-EMF networks and in situ measurement campaigns are tools largely used for the demonstration of the compliance of environmental EMF with safety limits for the general public. In Europe, five large monitoring networks (Greece, Catalonia in Spain, Romania, Serbia, and France–Belgium) are currently operating, consisting of more than 1200 measuring sensors. Continuous data from monitoring networks are very useful for the analysis of the temporal evolution of exposure [9,12]. Two large in situ measurement campaigns (Catalonia in Spain and France) also provide useful information on exposure. In situ measurement campaigns provide useful data for the variation in exposure in different microenvironments where people spend most of their time [16].

The population density of an area is a factor correlated with E-field levels: The higher the population density, the higher the E-field measured. This can be concluded from the measurements of monitoring networks, where we observed higher E-field values in those countries where the sensors are located in places with higher population density. This

conclusion was confirmed from in situ measurements within the same country (France), where the correlation was straightforward due to the large sample available.

However, the population density was not the only factor affecting measurement results. As shown in the case of the monitoring network in France–Belgium, sensor positioning was also an important factor: The higher the sensor was placed, the higher the E-field levels measured. This conclusion was confirmed by the in situ measurement campaign results in Catalonia in Spain, where the level/floor of each measurement location is available.

Differences exist in the design and deployment among different monitoring networks and in situ measurement campaigns. These differences can impose several problems and be misleading when trying to draw general conclusions. Such problems, among others, were faced in the current analysis of results in the cases of
(i) the France–Belgium monitoring network (due to different sensor positioning compared with other networks) and
(ii) the SMRF monitoring network (Catalonia, Spain) due to the gradual substitution of the probes with others operating in a broader frequency range.

Indeed, proper reporting of relevant parameters can mitigate these problems. As an example, we can mention the reporting of
(i) indoor/outdoor available information in France's in situ measurement campaign that enabled the demonstration of E-field vs. population density correlation and
(ii) the extent of the information available for measurement location (i.e. level) in the case of Catalonia's in situ measurements that enabled the demonstration of E-field vs. level/height correlation. In this context, a common framework for the development and operation of monitoring networks and in situ measurement campaigns could homogenize measurement results among different countries and significantly facilitate the attainment of useful conclusions.
Open access paper: https://www.mdpi.com/1424-8220/22/21/8481

COMPARATIVE ANALYSIS OF ELECTRIC FIELD STRENGTH, MAGNETIC FIELD STRENGTH AND POWER DENSITY AROUND THE CELL PHONE TOWERS OF VARYING CHARACTERISTICS WITH A PROPOSED CLASSIFICATION FACILITATING RESEARCH ON HUMAN POPULATION

Baliah J, Subramanian B, Livingstone D, Kanwal B, Zaman MU, Srivastava KC, Abutayyem H, Al-Johani K, David AP, Shrivastava D, Alam MK. International Journal of Environmental Research and Public Health. 2022; 19(21):14157. doi: 10.3390/ijerph192114157

Abstract

The continuous exposure of electromagnetic field (EMF) radiation from cell phone towers may possibly have an influence on public health. Each cell phone tower is unique in terms of number of antennas and its associated attributes; thus, the radiation exposure varies from one tower to another. Hence, a standardized method for quantifying the exposure is beneficial while studying the effects of radiation on the human population residing around the cell phone towers. A mere collection of data or human samples without understanding the cell phone tower differences may show study results such as an increase or decrease in biological parameters. Those changes may not be due to the effects of EMF radiation from cell phone towers but could be due to any other cause. Therefore, a comparative study was

designed with the aim of quantifying and comparing the electric field strength (EF), magnetic field strength (MF) and power density (PD) on four sides of cell phone towers with varying numbers of antennas at 50 m and 100 m. Further, an attempt was made to develop a PD-based classification for facilitating research involving human biological samples. Through convenience sampling, sixteen cell phone towers were selected. With the use of coordinates, the geographic mapping of selected towers was performed to measure the distance between the towers. Based on the number of antennas, the cell phone towers were categorized into four groups which are described as group I with 1–5 antennas, group II comprising of 6–10 antennas, group III consisting of 11–15 antennas and group IV comprised of towers clustered with more than 15 antennas. The study parameters, namely the EF, MF and PD, were recorded on all four sides of the cell phone towers at 50 m and 100 m. One-way ANOVA was performed to compare the study parameters among study groups and different sides using the Statistical Package for the Social Sciences (SPSS) version 25.0. The mean MF in Group IV was 2221.288 ± 884.885 μA/m and 1616.913 ± 745.039 μA/m at 50 m and 100 m respectively. The mean PD in Group IV at 50 m was 0.129 ± 0.094 μW/cm2 and 0.072 ± 0.061 μW/cm2 at 100 m. There was a statistically significant ($p < 0.05$) increase in the MF and PD at 50 m compared to 100 m among cell phone tower clusters with more than 15 antennas (Group IV). On the other hand, a non-significant increase in EF was observed at 50 m compared to 100 m in Group II and IV. The EF, MF and PD on all four sides around cell phone towers are not consistent with distance at 50 m and 100 m due to variation in the number of antennas.

Accordingly, a PD-based classification was developed as low, medium and high for conducting research involving any biological sample based on quantile. The low PD corresponds to 0.001–0.029, medium to 0.03–0.099 and high to 0.1–0.355 (μW/cm2). The PD-based classification is a preferred method over the sole criteria of distance for conducting human research as it measures the true effects of EMF radiation from the cell phone towers.

Open access paper: https://www.mdpi.com/1660-4601/19/21/14157

MEASUREMENT STUDIES OF PERSONAL EXPOSURE TO RADIOFREQUENCY ELECTROMAGNETIC FIELDS: A SYSTEMATIC REVIEW

Ramirez-Vazquez R, Escobar I, Vandenbosch GAE, Vargas F, Caceres-Monllor DA, Arribas E. Measurement studies of personal exposure to radiofrequency electromagnetic fields: A systematic review. Environ Res. 2022 Nov 29:114979. doi: 10.1016/j.envres.2022.114979.

Abstract

The last 25 years have seen an increase in the number of radiofrequency sources with the global adoption of smartphones as primary connectivity devices. The objective of this work was to review and evaluate the measured studies of personal exposure to Radiofrequency Electromagnetic Fields (RF-RMF) and meet the basic quality criteria eligible for inclusion in this Review, according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, following the eligibility criteria of the PECO (Population, Exposure, Comparator, and Outcome) methodology, and the instrument for critical reading Critical Appraisal Skills Programme Español (CASPe). We systematically reviewed the works published between January 1, 1998, and December 31, 2021, yielding 56 publications. Of the different types of studies in which personal exposure to RF-EMF has been measured with two measurement methodologies can be highlighted: Personal measurements with volunteers

and Personal measurements with a trained researcher (touring a specific area, one or several microenvironments, an entire city, walking or in some means of transport). Personal exposimeters were used in 83% of the studies. The lowest mean was measured in Egypt with a value of 0.00100 μW/m2 (1.00 nW/m2) in 2007 and the highest mean was measured in Belgium with a value of 285,000 μW/m2 (0.285 W/m2) in 2019.

The results of our study confirm that RF-EMF exposure levels are well below the maximum levels established by the ICNIRP guidelines.

https://pubmed.ncbi.nlm.nih.gov/36460078/

COMPARISON OF PERSONAL EXPOSURE TO RADIOFREQUENCY ELECTROMAGNETIC FIELDS FROM WI-FI IN A SPANISH UNIVERSITY OVER THREE YEARS

Ramirez-Vazquez R, Escobar I, Martinez-Plaza A, Arribas E. Comparison of personal exposure to Radiofrequency Electromagnetic Fields from Wi-Fi in a Spanish university over three years [published online ahead of print, 2022 Nov 8]. Sci Total Environ. 2022;160008. doi:10.1016/j.scitotenv.2022.160008.

Abstract

In this work we present the personal exposure levels to Radiofrequency Electromagnetic Fields (RF-EMF) from Wireless Fidelity (Wi-Fi) 2.4 GHz and 5.85 GHz bands in a Spanish university, specifically, at the Faculty of Computer Science Engineering at the University of Castilla-La Mancha (Albacete, Spain). We present results from three years, 2017, 2018 and 2019 in the same study place and points; and measurements carried out in 2022 inside a classroom and inside a professor's office, with the aim to compare the measurements and verify compliance with reference levels established by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). The minimum average was 0.0900 μW/m2 in the 2.4 GHz Wi-Fi, in 2019, and the maximum average was 211 μW/m2 in the 5.85 GHz Wi-Fi in 2017, around the building. Comparing the measurements carried out inside the classroom with students and without students, we identified that the maximum value was 278 μW/m2 (classroom with students, in the 5.85 GHz Wi-Fi band) and the minimum value was 37.9 μW/m2 (classroom without students, in the 5.85 GHz Wi-Fi band). Finally, comparing the results of all the measurements (average values) inside the classroom and inside a professor's office, the maximum value was 205 μW/m2 (in the 5.85 GHz Wi-Fi band) inside the classroom with students, and the minimum value was 0.217 μW/m2 inside a professor's office (in the 2.4 GHz Wi-Fi band). These values in no case exceed the limits established by the International Commission on Non-Ionizing Radiation Protection, 10 W/m2 for general public exposure.

https://pubmed.ncbi.nlm.nih.gov/36368387/

STUDY OF THE ELECTROMAGNETIC FIELD GENERATED BY WIRELESS COMMUNICATION SYSTEMS

S. Andreica, C. Munteanu, M. Gliga, C. Pacurar, A. Giurgiuman, C. Constantinescu. Study of the Electromagnetic Field Generated by Wireless Communication Systems. 2022 International Conference and Exposition on Electrical and Power Engineering (EPE), 2022, pp. 218-222, doi: 10.1109/EPE56121.2022.9959779.

Abstract

The aim of this paper is to outline the issue of exposure to electromagnetic radiation from communication systems (wireless routers, mobile phones) and to assess the intensity of the electric field to meet the levels within the limits imposed by law. The theme is a topical one because we use and are close to these devices every day, being exposed to the electromagnetic field both those who use the equipment and those who are close to it, lately this field being more and more publicized with the technological progress. Two generations of wireless routers were analyzed tracking electromagnetic field emissions depending on the position and number of users, this being done for mobile phones. A receiver microstrip antenna was also implemented to compare the results. The results obtained by experimental measurements, numerical modeling is presented and analyzed in this paper.

Conclusions

The values of the electric field intensity increase when we connect several devices, when we approach the field generator but also when we are at the level of the antennas of the wireless router. It is observed that the values of the electric field intensity do not exceed the limit of short-term exposure (61V/m). The highest value measured by us is 3.71 V/m for SMP2 positioning at, 0.1 m from the wireless router and at a height of 0.8 m from the ground, with two laptops connected to the wireless router from generation 4. However, this value exceeds the limit of 0.6 V m at long-term exposure. Following the analyzed studies, it is recommended to position the communication devices as far away from the human body as possible, in the case of the wireless router to position it in more isolated areas.

Comparing the results obtained for the two types of antennas, it can be stated that the antenna implementation was successful due to its functionality as a wireless antenna using it as a receiver, at a frequency of 2.4 GHz, together with the spectral analyzer. Comparing the results obtained with the microstrip antenna with those obtained with the telescopic antenna we can say that the results are similar.

https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9959779&isnumber=9959072

ACUTE RADIOFREQUENCY ELECTROMAGNETIC RADIATION EXPOSURE IMPAIRS NEUROGENESIS AND CAUSES NEURONAL DNA DAMAGE IN THE YOUNG RAT BRAIN

Singh KV, Prakash C, Nirala JP, Nanda RK, Rajamani P. Neurotoxicology. 2022 Nov 3:S0161-813X(22)00174-7. doi:10.1016/j.neuro.2022.11.001.

Highlights

- The study investigates the harmful effects of radiofrequency electromagnetic radiation (RF-EMR) exposure on the developing brain.
- RF-EMR exposure causes oxidative damage to lipids and DNA in the cerebral cortex and hippocampus region of the young brain.
- Hippocampal neurogenesis has been markedly reduced after RF-EMR exposure.
- RF-EMR exposure induces degenerative changes in dentate gyrus neurons.
- RF-EMR exposure does not activate the caspase-dependent apoptotic pathway.

Abstract

A mobile phone is now a commonly used device for digital media and communication among all age groups. Young adolescents use it for longer durations, which exposes them to radiofrequency electromagnetic radiation (RF-EMR). This exposure can lead to neuropsychiatric changes. The underlying cellular mechanism behind these changes requires detailed investigation. In the present study, we investigated the effect of RF-EMR emitted from mobile phones on young adolescent rat brains. Wistar rats (5 weeks, male) were exposed to RF-EMR signal (2,115MHz) at a head average specific absorption rate (SAR) of 1.51W/kg continuously for 8h. Higher level of lipid peroxidation, carbon-centered lipid radicals, and single-strand DNA damage was observed in the brain of rat exposed to RF-EMR. The number of BrdU-positive cells in the dentate gyrus (DG) decreased in RF-EMR- exposed rats, indicating reduced neurogenesis. RF-EMR exposure also induced degenerative changes and neuronal loss in DG neurons but had no effect on the CA3 and CA1 neurons of the hippocampus and cerebral cortex. The activity of Pro-caspase3 did not increase upon exposure in any of the brain regions, pointing out that degeneration observed in the DG region is not dependent on caspase activation. Results indicate that short-term acute exposure to RF-EMR induced the generation of carbon-centered lipid radicals and nuclear DNA damage, both of which likely played a role in the impaired neurogenesis and neuronal degeneration seen in the young brain's hippocampus region. The understanding of RF-EMR-induced alteration in the brain at the cellular level will help develop appropriate interventions for reducing its adverse impact. https://pubmed.ncbi.nlm.nih.gov/36336097/

THE EFFECTS OF LONG-TERM PRENATAL EXPOSURE TO 900, 1800, AND 2100 MHZ ELECTROMAGNETIC FIELD RADIATION ON MYOCARDIAL TISSUE OF RATS

Bozok S, Karaagac E, Sener D, Akakin D, Tumkaya L. The effects of long-term prenatal exposure to 900, 1800, and 2100 MHz electromagnetic field radiation on myocardial tissue of rats. Toxicol Ind Health. 2022;7482337221139586. doi:10.1177/07482337221139586

Abstract

It is well-known that wireless communication technologies facilitate human life. However, the harmful effects of electromagnetic field (EMF) radiation on the human body should not be ignored. In the present study, we evaluated the effects of long-term, prenatal exposure to EMF radiation on the myocardium of rats at varying durations. Overall, 18 pregnant Sprague-

Dawley rats were assigned into six groups (n = 3 in each group). In all groups other than the control group, three pregnant rats were exposed to EMF radiation (900, 1800 and 2100 MHz) for 6, 12 and 24 h over 20 days. After delivery, the newborn male pups were identified and six newborn male pups from each group were randomly selected. Then, histopathological and biochemical analysis of myocardial samples were performed. When 24-h/day prenatal exposures to 900, 1800, 2100 MHz EMF radiation were evaluated, myocardial damage was greater in the 2100 MHz EMF-24h group than the other groups. In addition, when malondialdehyde (MDA) and glutathione (GSH) levels associated with reactive oxidative species (ROS) were evaluated, the MDA level was higher in the 2100 MHz EMF-24h group compared with the other groups. The GSH level was also lower in the 2100 MHz EMF-24h group. When the 6, 12 and 24 h/day prenatal exposures to 1800 MHz EMF radiation were evaluated, myocardial damage was greater in 1800 MHz EMF-24h group than the remaining groups ($p < 0.0001$). Also, MDA level was greater in the 1800 MHz EMF-24h group compared with the other groups while the GSH level was lower in this group. It was shown that myocardial tissue was affected more by long-term exposure to EMF radiation at high frequencies. The data raise concerns that the harmful effects of non-ionizing radiation exposure on cardiac tissue will increase with 5G technology. https://pubmed.ncbi.nlm.nih.gov/36383165/

Excerpts

Control Group: The three pregnant rats in this group formed the sham group and were not exposed to radiation. 900 MHz/24h Group: The three pregnant rats in this group were continuously exposed to non-ionizing 900 MHz EMF radiation for 24 h per day over 20 days.

- 1800 MHz/6h Group: The three pregnant rats in this group were continuously exposed to non-ionizing 1800 MHz EMF radiation for 6 h per day over 20 days.
- 1800 MHz/12h Group: The three pregnant rats in this group were continuously exposed to non-ionizing 1800 MHz EMF radiation for 12 h per day over 20 days.
- 1800 MHz/24h Group: The three pregnant rats in this group were continuously exposed to non-ionizing 1800 MHz EMF radiation for 24 h per day over 20 days.
- 2100 MHz/24h Group: The three pregnant rats in this group were continuously exposed to non-ionizing 2100 MHz EMF radiation for 24 h per day over 20 days.

Each group was kept separately in the attended experiment boxes throughout study. Also, the control group was kept alone and isolated electromagnetically.

During the gestational period, a digital signal generator (Anritsu MG3670 B type, Japan) with an external antenna placed under the cage centrally was used for 900 MHz EMF exposure. The following parameters were used: maximal peak power, 2W; pulse width, 577 µsec; and modulation frequency, 217 Hz. The whole body average SAR was estimated as 0.087 W/kg using the finite integration technique (Alkis et al., 2019).

The same digital generator was used for 1800 MHz EMF exposure with following parameters: maximal peak power, 2W; pulse width, 577 µsec; and modulation frequency, 217 Hz. The whole body average SAR was estimated as 0.12 W/kg using the finite integration technique (Alkis et al., 2019).

The same digital generator was used for 2100 MHz EMF exposure with following parameters: maximal peak power, 2W; pulse width, 577 µsec; and modulation frequency, 217 Hz. The whole body average SAR was estimated as 0.17 W/kg using the finite integration technique (Alkis et al., 2019). In the study process, the radiation of the radiofrequency source was checked with a spectrum analyzer (Instek GSP 9330 TG, Taiwan) with its different probes....

Since fetal impact in pregnant women cannot be evaluated for ethical reasons, SAR values for EMF exposures ranging from 10 MHz to 2 GHz EMF were evaluated mathematically using a realistic modeling by Nagaoka, T et al. (2007). As a result of this study, in the vertical position, the mean SAR value of the whole body was found as 0.05–0.1 W/kg at 900 MHz EMF exposure whereas 0.125–0.25 W/kg at 2000 MHz exposure. These results were in agreement with the average SAR values generated with vertical EMF exposure in our experimental study....

... it is recommended that a pregnant working woman should be considered a member of the general population to maintain the fetal temperature at the level required by SAR restrictions in the general population. In the recommendations by International Commission on Non-Ionizing Radiation Protection (ICNIRP) in 2020 (ICNIRP, 2020), the limit SAR values recommended at frequencies between 100 KHz and 6 GHz are 0.4 W/Kg for the working population and 0.08 W/Kg for the general population. However, based on experimental studies in the literature, it can be suggested that exposure to EMF at these frequencies can affect biological systems even at lower intensities than the values recommended by ICNIRP (Al-Jarrah and Rababa, 2022). Despite not being a human study, our results support this conclusion given the SAR values in our experimental animal model....

Since wireless communication devices have been widely used in most countries for about 20 years and will be used for longer periods of time, it is not possible to fully predict their effects on human health. It is controversial whether the results of previous studies at lower frequencies and shorter exposures are still valid today. For this reason, further studies are needed to compare the effects of RF waves used in 5G networks with other RF wavelengths used in wireless communication.

In conclusion, it has been shown that myocardial tissue will be affected more by long-term EMF radiation exposure at high frequencies. For this reason, we are concerned that the harmful effects of non-ionizing radiation exposure on cardiac tissue will increase with 5G technology.

CHANGES IN HISTOPATHOLOGY AND PROTEINS RELATED TO THE MAPK PATHWAY IN THE BRAINS OF RATS EXPOSED TO PRE AND POSTNATAL RADIOFREQUENCY RADIATION OVER FOUR GENERATIONS

Tan B, Canturk Tan F, Yalcin B, Dasdag S, Yegin K, Yay AH. [published online ahead of print, 2022 Oct 29]. J Chem Neuroanat. 2022;126:102187. doi:10.1016/j.jchemneu.2022.102187

Highlights

- One of the most important research topics are effect of radiofrequency electromagnetic fields (RF-EMFs) on the central nervous system.
- EMF may cause changes in the function of the MAPK pathway, which affects cognitive processes such as learning and memory in rats.
- EMF may cause damage to both fetal and adult brain tissue in rats.
- Sufficient data are not available on generation studies investigate bio-effects of RF-EMFs.

Abstract

The development of new technologies and industry increases the number and variety of electromagnetic field (EMF) sources. Researchers are increasingly interested in the effects of EMF on brain health. The brain's function is largely dependent on electrical excitability, so it would be expected to be vulnerable to EMF. We therefore investigated the effects of brain development in the fetus, histopathological changes in female rats and the hippocampal level of MAPK proteins in male rats after exposed to pre and postnatal 2450MHz continuous wave (CW) radiofrequency radiation (RFR) over four generations.

Four groups: sham, irradiated female, irradiated male, irradiated male and female, with each consisting of four rats (one male and three females) were created. Rats in the exposure groups were whole-body exposed to 2450MHz CW-RFR for 12h/day during the experiment. Irradiation started one month before fertilization in the experimental group. On the 18th day of the gestational period, one pregnant rat from each group was decapitated under general anesthesia and the fetuses were taken. The remaining two pregnant rats completed the normal gestation period. When the offspring were two months old, four rats, one male and three female, were allocated for the second generation study. Next generation animals also experienced the same processes as the first generation rats. This study evaluated development of brain in fetuses and histopathological changes in brain of female rats using haematoxylin eosin staining, and the hippocampal level of MAPK proteins in brain of male rats by Western Blotting.

We observed hemorrhagic areas, irregular cellular localization and vascular structures in the brain of fetal and adult female rat of exposed groups in the all generations. pERK, ptau, pJNK and pP38 were increased in the brain of adult male rat of exposed groups in all generations ($p<0.005$).

Pre and postnatal 2450MHz continuous wave radiofrequency radiation exposure may cause changes in the function of the MAPK pathway affecting cognitive processes such as learning and memory and may cause damage to both the fetus and adult brain tissue. Also, EMF may have potential to affect brain of future generations.

https://pubmed.ncbi.nlm.nih.gov/36374647/

EFFECT OF RADIOFREQUENCY EXPOSURE ON BODY TEMPERATURE: REAL-TIME MONITORING IN NORMAL RATS

Kim HS, Kim Y, Jeon SB, Choi HD, Lee AK, Lee HJ, Pack JK, Kim N, Ahn YH. Effect of radiofrequency exposure on body temperature: Real-time monitoring in normal rats. J Therm Biol. 2022 Dec;110:103350. doi: 10.1016/j.jtherbio.2022.103350.

Abstract

Radiofrequency radiation (RFR) can generate heat in living organisms. In this study, we monitored the body temperature of healthy animals during RFR exposure in real time using an implantable iButton data logger. A reverberation chamber system for small animals was used for this radiofrequency (RF) exposure in vivo study. Healthy male Sprague-Dawley rats were divided into two groups: with versus without iButton implantation (n = 20 per group). Each group was further divided into a sham-exposed and RF-exposed group (n = 10 per subgroup). Rats were exposed to a 1,760-MHz long-term evolution (LTE) signal in the reverberation chamber system at a whole-body average specific absorption rate of 0 W/kg (sham-exposed) or 4 W/kg (RF-exposed) for 6h. The body temperature of iButton-implanted rats was recorded using an intraperitoneally implanted iButton every minute over 6 h of RF exposure, whereas that of non-implanted rats was measured directly using a rectal thermometer immediately before and after the 6-h RF exposure period. The temperature values measured by the two types of thermometers were significantly positively correlated ($r = 0.63$, $P < 0.01$, linear regression), and changes in body temperatures recorded in iButton-implanted and non-implanted rats measured using two thermometers after 6 h of RF exposure were maintained within <1°C ($P = 0.87$, general linear model, followed by univariate model). Similar results were obtained for rectal thermometer measurements ($P = 0.12$, paired t-test). These results suggest that RF exposure at a whole-body average specific absorption rate of 4 W/kg does not induce significant changes in body temperature in healthy rats over a 6-h RF exposure period. https://pubmed.ncbi.nlm.nih.gov/36462859/

Highlights

- RF exposure of 4 W/kg wbSAR is known to alter rat behavior, but it is unclear whether it raises body temperature.
- The iButton, an implantable intraperitoneal thermometer, can be used to monitor body temperature in real time.
- Body temperatures measured by both the iButton and the rectal thermometer and the temperature change patterns were similar.
- The body temperature of healthy rats was not altered by RF exposure of 4 W/kg wbSAR. Reverberation chamber for RF exposure

The methods used in this study were adapted from those of a previous study (Jin et al., 2021). Briefly, a reverberation chamber (IRETEC, Anyang, Korea) was used as the RF exposure system. The external dimensions (L × W × H) of the reverberation chamber were 2,295 × 2,293 × 1,470 mm. An LTE RF source with a center frequency of 1,706 MHz, a bandwidth of 20 MHz, and quadrature phase-shift keying modulation was used in this study. The input signal was amplified using a high-power amplifier (PCS60WHPA_CW; Kortcom Co., Anyang, Korea). The output power level (maximum: 60 W) was controlled using an 11-bit digital PIN diode attenuator (model 349; General Microwave, Farmingdale, NY, USA). Commercial transmitting

antennae (patch type, KCAN1900PA; Korea Telecommunication Components, Anyang, Korea) were used. Exposure level and time were set using a computer. The input power was monitored in real time using a power meter (N1912A, Keysight, Santa Rosa, CA, USA) through a 20-dB directional coupler (778D, Keysight). The field uniformity of the reverberation chamber was measured at 24 points within the working volume. An isotropic field probe (HI-6005; ETS-Lindgren) was used for electric field measurements. Uniformity averaged over a period of 1 min was evaluated. The field distribution in the working volume remained within ±2 dB. The chambers were installed at the Korea Institute of Radiological & Medical Sciences in Seoul, Korea. The reverberation chamber was housed at an animal facility, and its ventilation, temperature, and humidity were controlled. The SAR distribution was calculated for each caged rat using a rat phantom (Electronics and Telecommunications Research Institute, Daejon, Korea); the simulation featured 40 tissues and a voxel size of 1 mm. The power output was adjusted to 45.5 W to achieve a wbSAR of 4 W/kg.

PRE-EXPOSURE TO RADIOFREQUENCY ELECTROMAGNETIC FIELDS AND INDUCTION OF RADIOADAPTIVE RESPONSE IN RATS IRRADIATED WITH HIGH DOSES OF X-RAYS

Borzoueisileh S, Shabestani Monfared A, Mortazavi SMJ, Zabihi E, Pouramir M, Niksirat F, Seyfizadeh N, Shafiee M. Pre-Exposure to Radiofrequency Electromagnetic Fields and Induction of Radioadaptive Response in Rats Irradiated with High Doses of X-Rays. J Biomed Phys Eng. 2022 Oct 1;12(5):505-512. doi: 10.31661/jbpe.v0i0.1271.

Abstract

Background: Some evidence shows that a pre-exposure to RF can mitigate the effects of subsequent exposures to high doses of ionizing radiation.

Objective: We aimed to assess the effect of a pre-exposure to non-ionizing RF radiation on survival, weight changes, food consumption, and water intake of lethally irradiated rats.

Material and methods: In this case-control study, we used a commercial mobile phone (GSM, 900/1800 MHz) as well as a 2.4 GHz Wi-Fi router as the sources of pre-exposure to RF radiation. Forty-eight rats were randomly divided into six groups of control, "8 Gy X-rays", mobile phone, "mobile phone+8 Gy", Wi-Fi, and "Wi-Fi+8 Gy". Then, the survival fraction, weight loss, water, and food consumption changes were compared in different groups.

Results: The survival analysis indicated that the survival rates in all of the exposed animals ("8 Gy X-rays", "mobile phone+8 Gy", "Wi-Fi+8 Gy") were significantly lower than the control, "Wi-Fi", and "mobile phone" groups. The changes in survival rates of "mobile+8 Gy", "Wi-Fi+8 Gy", and 8 Gy alone were not statistically significant. However, food and water intake were significantly affected by exposure to both RF pre-exposures and exposure to high dose ionizing radiation.

Conclusion: To the best of our knowledge, the existence of a dose window for the induction of AR [adaptive response] can be the cause of the lack of AR in our experiment. Our findings confirm that in a similar pattern with the adaptive responses induced by pre-exposure to ionizing radiation, the induction of adaptive response by RF-pre-exposures requires a minimum level of damage to trigger adaptive phenomena.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9589077/

EFFECTS OF HEAT AND WIFI (2.4 GHZ) EXPOSURE ON RAT CARDIOVASCULAR SYSTEM

Jafari M, Masoudi E, Sotoudeh N, Hosseini S F. Effects of Heat and WiFi (2.4 GHz) Exposure on Rat Cardiovascular System. Health Scope. 2022;11(3):e120282. doi:10.5812/jhealthscope-120282

Abstract

Background: Today, wireless communication systems are destructive with increased lipid peroxidation and oxidation state and have adverse biological effects on human health.

Objectives: In this study, we examined the effects of exposure to WiFi wireless frequency (2.4 GHz) on histopathological changes in the cardiovascular system of rats.

Methods: The experimental groups included 32 adult male rats divided into control (not exposed to heat and WiFi), WiFi (exposed to 2.45 GHz for 52 consecutive days (2 h/day)), heat (water bath of 43°C for 52 consecutive days (10 min/day)), and heat+WiFi groups (exposed to 2.45 GHz then water bath of 43°C). On the 52nd day, the heart was removed, and its total volume and weight were determined using stereological techniques. The number of cardiomyocytes nuclei and the volume of the myocardium were determined. Blood samples were collected to measure reduced glutathione (GSH) content, Total Antioxidant Capacity (TAC), and malondialdehyde level (MDA). Data were analyzed by ANOVA, Kruskal-Wallis, and Mann-Whitney U tests.

Results: The heart weight and volume density of the myocardium increased in the WiFi-irradiated group compared to the control group ($P < 0.05$). Also, exposure to WiFi increased MDA levels and decreased TAC and GSH compared to the control group ($P < 0.05$).

Conclusions: This study indicated that RFW might cause structural changes and oxidative stress in the heart. Also, exposure to radiofrequency decreased total antioxidant activity in heart tissue with histological changes, including myocardium hypertrophy and decreased number of myocytes.

Open access paper: https://brieflands.com/articles/healthscope-120282.html

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HISTOMORPHOMETRIC ANALYSIS OF CHICK EMBRYO KIDNEYS ON EXPOSURE TO 1800 MHZ AND 2100 MHZ RADIOFREQUENCY RADIATION EMITTED FROM CELL PHONE

Dsilva MH, Swer RT, Anbalagan J. Histomorphometric Analysis of Chick Embryo Kidneys on Exposure to 1800 MHz and 2100 MHz Radiofrequency Radiation Emitted from Cell Phone. J Clin of Diagn Res. 2022; 16(10):AC01- AC05. doi:10.7860/JCDR/2022/58391/16862

Abstract

Introduction: With its sophisticated and multifunctional features, the cell phone has become an integral part of human life. Scientific reports are still inconclusive, regarding the possible ill effects of Radiofrequency Radiation (RFR) emitted from cell phones on biological tissues.

Aim: To evaluate the possible tissue damage in developing kidneys of chick embryos, following exposure to 1800 MHz and 2100 MHz radiofrequency radiation emitted from 2G and 3G cell phones.

Materials and Methods: This experimental study was conducted in Department of Anatomy at Mahatma Gandhi Medical College and Research Institute, Puducherry, India, from August 2011 to June 2015. Fertilised chick embryos (144Â±20 eggs) were divided into three groups with a sample size of 48 eggs per group. Group A was exposed to 2G radiation (1800 MHz), group B was exposed to 3G radiation (2100 MHz) and group C was a sham exposed control group. The embryos were sacrificed from the 5th-12th day, and processed for routine histological procedures, to check structural and morphometric changes in the kidney. The standard epithelial height and nuclear diameter of both proximal convoluted tubule and distal convoluted tubule, karyorrhexis changes and diameter of urinary space were analysed using an ocular micrometer and square reticle. The results were statistically analysed using one-way Analysis of Variance (ANOVA).

Results: The results showed cytoplasmic changes (vacuolations) and nuclear changes (nucleomegaly, karyorrhexis) in proximal convoluted tubule and distal convoluted tubule, vascular changes (haemorrhage and infiltrations) in the interstitium and increased urinary space in the glomerulus of chick embryo kidneys.

Conclusion: Based on the study findings, it was concluded that RFR exposure from cell phones causes histopathological changes in the developing kidneys of chick embryos.

Open access paper:
https://www.jcdr.net//article_fulltext.asp?issn=0973709x&year=2022&month=October&volume=16&issue=10&page=AC01-AC05&id=16862

2.4 GHZ ELECTROMAGNETIC FIELD INFLUENCES THE RESPONSE OF THE CIRCADIAN OSCILLATOR IN THE COLORECTAL CANCER CELL LINE DLD1 TO MIR-34A-MEDIATED REGULATION

Olejárová S, Moravčík R, Herichová I. 2.4 GHz Electromagnetic Field Influences the Response of the Circadian Oscillator in the Colorectal Cancer Cell Line DLD1 to miR-34a-Mediated Regulation. Int J Mol Sci. 2022 Oct 30;23(21):13210. doi: 10.3390/ijms232113210. PMID: 36361993.

Abstract

Radiofrequency electromagnetic fields (RF-EMF) exert pleiotropic effects on biological processes including circadian rhythms. miR-34a is a small non-coding RNA whose expression is modulated by RF-EMF and has the capacity to regulate clock gene expression. However, interference between RF-EMF and miR-34a-mediated regulation of the circadian oscillator has not yet been elucidated. Therefore, the present study was designed to reveal if 24 h exposure to 2.4 GHz RF-EMF influences miR-34a-induced changes in clock gene expression, migration and proliferation in colorectal cancer cell line DLD1. The effect of up- or downregulation of miR-34a on DLD1 cells was evaluated using real-time PCR, the scratch assay test and the MTS test. Administration of miR- 34a decreased the expression of per2, bmal1, sirtuin1 and survivin and inhibited proliferation and migration of DLD1 cells. When miR-34a-transfected DLD1 cells were exposed to 2.4 GHz RF-EMF, an increase in cry1 mRNA expression was observed. The inhibitory effect of miR-34a on per2 and survivin was weakened and abolished, respectively. The effect of miR-34a on proliferation and migration was eliminated by RF-EMF exposure. In conclusion, RF-EMF strongly influenced regulation

mediated by the tumour suppressor miR-34a on the peripheral circadian oscillator in DLD1 cells.

Excerpt
To test the effect of RF-EMF on gene expression, DLD1 cells were exposed to a pulsed electromagnetic field, generated by a D-Link GO-RT-N150 Wi-Fi router (D-Link, Taipei, Taiwan), during 24 h. The radiofrequency range was 2426 to 2448 MHz (Wi-Fi channel 6), pulse length was 2.76 ms, pulse frequency was 9.7 Hz, pulse risetime was 0.06–0.08 µs, and pulse falltime was 0.067–0.107 µs.

Radiofrequency field power flux density at the level of the cell layer was 1 W/m2 (19 V/m) peak, 0.12 W/m2 (6.6 V/m) RMS. Plates with sham-exposed cells were during this time covered by radiofrequency protective foil YSHIELD HNV100 (YSHIELD GmbH & Co. KG, Ruhstorf an der Rott, Germany). Other conditions were identical for both groups: powerline frequency electric field (50 Hz) at the level of cell layer was below 1 V/m, powerline frequency magnetic field at the level of cell layer was 0.3 µT in both control and experimental groups.

Conclusions
In conclusion, the present study revealed new target genes of miR-34a-5p with key roles in the circadian oscillator functioning– per2, bmal1 and cry1. In the case of per2 and bmal1, miR-34a-5p downregulated gene expression, and this effect was most likely mediated via the 3'UTR region. cry1 mRNA expression was upregulated after miR-34a administration, and this influence is more likely to be mediated by an alternative way of miRNA functioning.

Interestingly, exposure to RF-EMF potentiates the capacity of miR-34a to induce the expression of clock genes with oncogenic capacity—cry1 and cry2. Moreover, the functioning of the miR-34a inhibitor was weakened when cells were exposed to RF-EMF, and consequently, the increase in tumour-suppressive per2 mRNA expression induced by the miR-34a inhibitor was less pronounced under RF-EMF conditions compared to the control. Similarly, miR-34a inhibited the expression of anti-apoptotic protein survivin was diminished when cells were exposed to RF-EMF. RF-EMF have been classified by the WHO as possibly carcinogenic for humans. Our data are in line with this conclusion, as the results indicate that RF-EMF can shift the influence of miR-34a in cancer progression manifested by analysed target genes from typical tumour-suppressive to neutral or slightly oncogenic.
Open access paper: https://www.mdpi.com/1422-0067/23/21/13210

EFFECT OF RADIOFREQUENCY ELECTROMAGNETIC RADIATION EMITTED BY MODERN CELLPHONES ON SPERM MOTILITY AND VIABILITY: AN IN VITRO STUDY
Chu KY, Khodamoradi K, Blachman-Braun R, et al. Effect of Radiofrequency Electromagnetic Radiation Emitted by Modern Cellphones on Sperm Motility and Viability: An In Vitro Study [published online ahead of print, 2022 Nov 12]. Eur Urol Focus. 2022;S2405-4569(22)00247-4. doi:10.1016/j.euf.2022.11.004.

Abstract
Background: Cellphones emit radiofrequency electromagnetic radiation (RF-EMR) for transmission of data for social media communication, web browsing, and music/podcast streaming. Use of Bluetooth ear buds has probably prolonged the time during which

cellphones reside in the trouser pockets of men. It has been postulated that RF-EMR increases oxidative stress and induces free radical formation.

Objective: To investigate the effect of wireless-spectrum (4G, 5G, and WiFi) RF-EMR emitted by modern smartphones on sperm motility and viability and explore whether these effects can be mitigated using a physical barrier or distance.

Design, setting, and participants: Semen samples were obtained from fertile normozoospermic men aged 25-35 yr. A current-generation smartphone in talk mode was used as the RF-EMR source. A WhatsApp voice call was made using either 4G, 5G, or WiFi wireless connectivity. We determined if exposure effects were mitigated by either a cellphone case or greater distance from the semen sample.

Outcome measurements and statistical analysis: The semen samples were analyzed according to 2010 World Health Organization laboratory guidelines. Statistical analysis was performed using SPSS v.28.

Results and limitations: We observed decreases in sperm motility and viability with WiFi exposure but not with exposure to 4G or 5G RF-EMR. With large variability among smartphones, continued research on exposure effects is needed.

Conclusions: Our exploratory study revealed that sperm motility and viability are negatively impacted by smartphones that use the WiFi spectrum for data transmission.

Patient summary: We looked at the effect of cellphone use on sperm motility and viability. We found that cellphones using WiFi connectivity for data usage have harmful effects on semen quality in men. https://pubmed.ncbi.nlm.nih.gov/36379868/

ELECTROMAGNETIC INTERACTIONS IN REGULATIONS OF CELL BEHAVIORS AND MORPHOGENESIS

Sun G, Li J, Zhou W, Hoyle RG, Zhao Y. Electromagnetic interactions in regulations of cell behaviors and morphogenesis. Front Cell Dev Biol. 2022;10:1014030. Published 2022 Oct 19. doi:10.3389/fcell.2022.1014030

Abstract

Emerging evidence indicates that the cellular electromagnetic field regulates the fundamental physics of cell biology. The electromagnetic oscillations and synchronization of biomolecules triggered by the internal and external pulses serve as the physical basis of the cellular electromagnetic field. Recent studies have indicated that centrosomes, a small organelle in eukaryotic cells that organize spindle microtubules during mitosis, also function as a nano-electronic generator in cells. Additionally, cellular electromagnetic fields are defined by cell types and correlated to the epigenetic status of the cell. These interactions between tissue-specific electromagnetic fields and chromatin fibers of progenitor cells regulate cell differentiation and organ sizes. The same mechanism is implicated in the regulation of tissue homeostasis and morphological adaptation in evolution. Intercellular electromagnetic interactions also regulate the migratory behaviors of cells and the morphogenesis programs of neural circuits. The process is closely linked with centrosome function and intercellular

communication of the electromagnetic fields of microtubule filaments. Clearly, more and more evidence has shown the importance of cellular electromagnetic fields in regulatory processes. Furthermore, a detailed understanding of the physical nature of the inter- and intracellular electromagnetic interactions will better our understanding of fundamental biological questions and a wide range of biological processes.
Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9627210/

WAVE-LIKE PATTERNS IN PARAMETER SPACE INTERPRETED AS EVIDENCE FOR MACROSCOPIC EFFECTS RESULTING FROM QUANTUM OR QUANTUM-LIKE PROCESSES IN THE BRAIN

Kurtev S. Wave-like patterns in parameter space interpreted as evidence for macroscopic effects resulting from quantum or quantum-like processes in the brain. Sci Rep. 2022;12(1):18938. Published 2022 Nov 7. doi:10.1038/s41598-022-22661-8

Abstract

Data from eight numerosity estimation experiments reliably exhibit wave-like patterns in plots of the standard deviations of the response times along the abstract parameter of the magnitude of the error in the numerosity estimation. An explanation for this phenomenon is proposed in terms of an analogy between response times and error magnitude on one hand, and energy and position of quantum particles on the other, constructed using an argument for an overlap between the mathematical apparatus describing Hopfield-type neural networks and quantum systems, established by some researchers. Alternative explanations are presented within the traditional explanatory framework of oscillations due to neural firing, involving hypothetical mechanisms for converting oscillation patterns in time to oscillation patterns in the space of an abstract parameter, such as the magnitude of the error during numerosity estimation. The viability of the proposal of causal influences propagating from the microscale of quantum phenomena to the macroscale of human behavior, needed for the first type of explanation, is exemplified by the phenomenon of magnetoreception in some species of birds, which is allegedly quantum in nature.
Open access paper: https://www.nature.com/articles/s41598-022-22661-8

NEW VIEW ON THE IMPACT OF THE LOW-FREQUENCY ELECTROMAGNETIC FIELD (50 HZ) ON STRESS RESPONSES - HORMESIS EFFECT

Klimek A, Kletkiewicz H, Siejka A, Wyszkowska J, Maliszewska J, Klimiuk M, Jankowska M, Seckl J, Rogalska J. New view on the impact of the low-frequency electromagnetic field (50 Hz) on stress responses - hormesis effect. Neuroendocrinology. 2022 Nov 2. doi: 10.1159/000527878.

Abstract

Introduction: Low-frequency electromagnetic field (50 Hz) (EMF) can modify crucial neuronal processes. Existing data indicate that exposure to EMF may represent a mild stressor and contribute to disturbances of hypothalamic-pituitary-adrenal (HPA) axis. The important regulatory pathways controlling HPA axis activity include two types of corticosteroid receptors: mineralocorticoid (MR) and glucocorticoid (GR) receptors. There are particularly abundant in the hippocampus, a key locus of HPA axis feedback control. The research aimed at determining whether 1) EMF exhibits hormesis, it means bidirectional action depending on

EMF intensity (1 or 7 mT), and 2) repeated EMF exposure changes stress response to subsequent stress factors.

Methods: The exposure (7-day, 1h/day) of adult rats to EMF (1 mT and 7 mT) was repeated 3 times. HPA axis hormones and their receptors were analysed after each following exposure. Moreover, the impact of EMF exposure on hormonal and behavioural responses to subsequent stress factor - open-field test was evaluated.

Results/discussion: Our data suggest that exposure to EMF can establish a new "set-point" for HPA axis activity. The direction and dynamics of this process depend on the intensity of EMF and the number of exposures. EMF of 1 mT induced an adaptive stress response, but 7 mT EMF caused sensitization. Consequently, EMF changed the vulnerability of the organism to a subsequent stress factor. We have also shown the increase of MR mRNA abundance in hippocampus of 1 mT EMF exposed rats, which can represent the possible neuroprotective response and suggest therapeutic properties of electromagnetic fields.
https://pubmed.ncbi.nlm.nih.gov/36323227/

INVESTIGATION OF EXTREMELY LOW-FREQUENCY (1 HZ-400 KHZ) POLLUTION FREQUENTLY ENCOUNTERED IN SOCIAL LIFE: A CASE STUDY OF A SHOPPING MALL

Emeksiz C. Investigation of extremely low-frequency (1 Hz-400 kHz) pollution frequently encountered in social life: a case study of a shopping mall. Environ Sci Pollut Res Int. 2022 Nov 3. doi: 10.1007/s11356-022-23843-7.

Abstract

It is important to periodically measure, analyze, and map electromagnetic radiation levels due to potential risks. This study aims to draw attention to new electromagnetic pollution caused by radio frequencies and extremely low frequencies. For this reason, electric field and magnetic field measurements were carried out in the 1-Hz- 400-kHz frequency band in a shopping mall, where electronic devices cause low-frequency electromagnetic radiation intensively. The measurements were performed with the EHP-50F device for 24 h a day for a week.

The measurements were made at 10 points in the shopping mall, and the measurement results were evaluated over five different sectors: electronics, clothing and accessories (male-female), personal care and cosmetics, supermarket, and the playland for children. Magnetic maps of each sector were produced. In addition, the specific absorption rates (SAR) of male and female customers in these workplaces were determined. This is the first study carried out to find SAR caused by low-frequency radiation. Although the safe limit value of SAR for the whole body is 0.08 W/kg, the SAR values calculated in the playland and electronics sectors were obtained to be 0.763 and 0.39 W/kg, respectively. Results clearly demonstrate how especially small children are exposed to danger in the long term. https://pubmed.ncbi.nlm.nih.gov/36327086/

Conclusions

In this study, five main topics were discussed: the determination of 10 different measurement points at the largest shopping mall in the province of Tokat, Turkey; a grouping of the measurement points by service sectors; measurement of low-frequency electric and magnetic

field values; determination of electromagnetic pollution maps of measurement points; and analysis of SAR values.

First of all, workplaces designated for measuring points in the shopping mall were divided into 5 service groups: electronics, clothing and accessories (male–female), personal care and cosmetics, supermarket, and the playland. The coordinates and measurements of the workplaces were carried out meticulously. The information obtained was entered separately to the measurement points in the shopping mall, and a low-frequency electromagnetic pollution map was obtained. Exposure to SAR in male and female customer groups was compared to biological limits defined by ICNIRP, where adverse effects start to appear.

The results obtained are as follows:

1) The evaluation of the data collected from 10 points of measurement for a week showed that the playland region, which serves children, has the highest electric and magnetic field values. In this region, an average electric field of 52.666 V/m and a magnetic field of 0.046 μT were measured for a week. According to the measured electric field, the SAR ratio was found to be 0.763 W/kg, above the maximum values. The electronic service sector was ranked second sector which exceeds the safety limits.
2) The lowest average electric and magnetic field values (1.398 V/m, 0.044 μT) were obtained in the supermarket sector. Accordingly, the lowest SAR value was also determined at the measuring points of this sector.
3) The maximum and minimum electric field values were obtained on different days of the week, as shown in the tables that present the statistical evaluation of the measurement results. Therefore, customers will be exposed to different impacts on different days of the week.
4) In determining the SAR rates, the safety limit for the whole body was taken as a reference. Both male and female customers were evaluated separately. In the calculations, individuals with a normal body mass index were preferred. This is because the overweight and obese groups are more exposed to SAR than the normal groups.
5) Although male and female customers are exposed to high amounts of electromagnetic radiation, the duration of radiation exposure is also of importance. And, although customers are exposed to this radiation for a short period of time, employees in these workplaces are exposed to the radiation for at least 10 h every day.

Consequently, as a common place for a shopping habit that emerged in today's societies, shopping malls are the points where low-frequency electromagnetic radiation is seen intensively. In addition, the decrease in children's play areas due to rapid urbanization causes parents to spend a large part of their children's time in the play areas in shopping malls. Given the literature studies that draw attention to the impact of low-frequency electromagnetic radiation, it is once again seen how important the politicians' responsibilities are in providing a safe and healthy environment for all of us.

INTERMITTENT ELF-MF INDUCE AN AMPLITUDE-WINDOW EFFECT ON UMBILICAL CORD BLOOD LYMPHOCYTES

Zastko L, Makinistian L, Tvarožná A, Belyaev I. Intermittent ELF-MF Induce an Amplitude-Window Effect on Umbilical Cord Blood Lymphocytes. Int J Mol Sci. 2022;23(22):14391. Published 2022 Nov 19. doi:10.3390/ijms232214391

Abstract

In a previous study of the effects of intermittent extremely low frequency (ELF) magnetic fields (MF) on umbilical cord blood lymphocytes (UCBL), we evaluated MF amplitudes between 6 μT and 24 μT and found an effect only for those below 13 μT. This suggested the existence of an amplitude window. In this brief communication, we further tested this hypothesis. UCBLs from healthy newborns were isolated and exposed for 72 h to an intermittent ELF-MF (triangular, 7.8 Hz, 250 s ON/250 s OFF) with 6 different amplitudes between 3 μT and 12 μT, utilizing an oblong coil. Percentage of viable, early apoptotic (EA), and late apoptotic/necrotic (LAN) cells were determined by flow cytometry. Moreover, reactive oxygen species (ROS) were determined at 1 h and 3 h of the exposure. Like in our previous work, neither EA, nor LAN, nor ROS were statistically significantly affected by the intermittent ELF-MF. However, the percentage of viable cells was decreased by exposure to the fields with intensities of 6.5 μT and 12 μT ($p < 0.05$; and $p = 0.057$ for 8.5 μT). ELF-MF decreased the percentage of viable cells for fields down to 6.5 μT, but not for 5 μT, 4 μT, or 3 μT. Combined with our previous findings, the results reported here indicate an amplitude window effect between 6 μT and 13 μT. The obtained data are in line with a notion of amplitude and frequency windows, which request scanning of both amplitude and frequency while studying the ELF-MF effects.

Open access paper: https://www.mdpi.com/1422-0067/23/22/14391

A 50 HZ MAGNETIC FIELD INFLUENCES THE VIABILITY OF BREAST CANCER CELLS 96 H AFTER EXPOSURE

Elexpuru-Zabaleta M, Lazzarini R, Tartaglione MF, et al. A 50 Hz magnetic field influences the viability of breast cancer cells 96 h after exposure. 2022 Nov 15]. Mol Biol Rep. 2022;10.1007/s11033-022-08069-7. doi:10.1007/s11033-022-08069-7.

Abstract

Background: The exposure of breast cancer to extremely low frequency magnetic fields (ELF-MFs) results in various biological responses. Some studies have suggested a possible cancer-enhancing effect, while others showed a possible therapeutic role. This study investigated the effects of in vitro exposure to 50 Hz ELF-MF for up to 24 h on the viability and cellular response of MDA-MB-231 and MCF-7 breast cancer cell lines and MCF- 10A breast cell line.

Methods and results: The breast cell lines were exposed to 50 Hz ELF-MF at flux densities of 0.1 mT and 1.0 mT and were examined 96 h after the beginning of ELF-MF exposure. The duration of 50 Hz ELF-MF exposure influenced the cell viability and proliferation of both the tumor and nontumorigenic breast cell lines. In particular, short-term exposure (4-8 h, 0.1 mT and 1.0 mT) led to an increase in viability in breast cancer cells, while long and high exposure (24 h, 1.0 mT) led to a decrease in viability and proliferation in all cell lines. Cancer and normal breast cells exhibited different responses to ELF-MF. Mitochondrial membrane potential and

reactive oxygen species (ROS) production were altered after ELF-MF exposure, suggesting that the mitochondria are a probable target of ELF-MF in breast cells.

Conclusions: The viability of breast cells in vitro is influenced by ELF-MF exposure at magnetic flux densities compatible with the limits for the general population and for workplace exposures. The effects are apparent after 96 h and are related to the ELF-MF exposure time.
https://pubmed.ncbi.nlm.nih.gov/36378418/

HYPOMAGNETIC FIELD EXPOSURE AFFECTING GUT MICROBIOTA, REACTIVE OXYGEN SPECIES LEVELS, AND COLONIC CELL PROLIFERATION IN MICE

Zhan A, Luo Y, Qin H, Lin W, Tian L. Hypomagnetic Field Exposure Affecting Gut Microbiota, Reactive Oxygen Species Levels, and Colonic Cell Proliferation in Mice. Bioelectromagnetics. 2022;10.1002/bem.22427. doi:10.1002/bem.22427

Abstract

The gut microbiota has been considered one of the key factors in host health, which is influenced by many environmental factors. The geomagnetic field (GMF) represents one of the important environmental conditions for living organisms. Previous studies have shown that the elimination of GMF, the so-called hypomagnetic field (HMF), could affect the physiological functions and resistance to antibiotics of some microorganisms. However, whether long-term HMF exposure could alter the gut microbiota to some extent in mammals remains unclear. Here, we investigated the effects of long-term (8- and 12-week) HMF exposure on the gut microbiota in C57BL/6J mice. Our results clearly showed that 8-week HMF significantly affected the diversity and function of the mouse gut microbiota. Compared with the GMF group, the concentrations of short-chain fatty acids tended to decrease in the HMF group. Immunofluorescence analysis showed that HMF promoted colonic cell proliferation, concomitant with an increased level of reactive oxygen species (ROS). To our knowledge, this is the first in vivo finding that long-term HMF exposure could affect the mouse gut microbiota, ROS levels, and colonic cell proliferation in the colon. Moreover, the changes in gut microbiota can be restored by returning mice to the GMF environment, thus the possible harm to the microbiota caused by HMF exposure can be alleviated.
https://pubmed.ncbi.nlm.nih.gov/36434792/

INFLUENCE OF HYPOMAGNETIC FIELD ON THE HEARTBEAT IN ZEBRAFISH EMBRYOS

Krylov V, Machikhin A, Sizov D, et al. Influence of hypomagnetic field on the heartbeat in zebrafish embryos. Front Physiol. 2022;13:1040083. Published 2022 Oct 21. doi:10.3389/fphys.2022.1040083.

Abstract

The magnetic environment may influence the functioning of the cardiovascular system. It was reported that low- frequency and static magnetic fields affect hemodynamics, heart rate, and heart rate variability in animals and humans. Moreover, recent data suggest that magnetic fields affect the circadian rhythms of physiological processes. The influence of the magnetic environment on heart functionating during early development has been studied insufficiently. We utilized transparent zebrafish embryos to evaluate the effect of the hypomagnetic field on the characteristics of cardiac function using a noninvasive optical approach based on photoplethysmographic microscopic imaging. The embryos were exposed to the geomagnetic

and hypomagnetic fields from the second to the 116th hour post fertilization under a 16 h light/8 h dark cycle or constant illumination. The exposure of embryos to the hypomagnetic field in both lighting modes led to increased embryo mortality, the appearance of abnormal phenotypes, and a significant increase in the embryo's heartbeat rate.

The difference between maximal and minimal heartbeat intervals, maximal to minimal heartbeat intervals ratio, and the coefficient of variation of heartbeat rate were increased in the embryos exposed to the hypomagnetic field under constant illumination from 96 to 116 h post fertilization. The dynamics of heartbeat rate changes followed a circadian pattern in all studied groups except zebrafish exposed to the hypomagnetic field under constant illumination. The results demonstrate the importance of natural magnetic background for the early development of zebrafish. The possible mechanisms of observed effects are discussed.
Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9634549/

OBSERVED ELECTRIC CHARGE OF INSECT SWARMS AND THEIR CONTRIBUTION TO ATMOSPHERIC ELECTRICITY

Hunting ER, O'Reilly LJ, Harrison RG, Manser K, England SJ, Harris BH, Robert D. Observed electric charge of insect swarms and their contribution to atmospheric electricity. iScience. 25(11):105241. 2022. doi:10.1016/j.isci.2022.105241.

Abstract

The atmosphere hosts multiple sources of electric charge that influence critical processes such as the aggregation of droplets and the removal of dust and aerosols. This is evident in the variability of the atmospheric electric field. Whereas these electric fields are known to respond to physical and geological processes, the effect of biotic sources of charge has not hitherto been considered. Here, we combine theoretical and empirical evidence to demonstrate that honeybee swarms directly contribute to atmospheric electricity, in proportion to the swarm density. We provide a quantitative assessment of this finding, by comparing the electrical contribution of various swarming insect species with common abiotic sources of charge. This reveals that the charge contribution of some insect swarms will be comparable with that of meteorologically induced variations. The observed transport of charge by insects therefore demonstrates an unexplored role of biogenic space charge for physical and ecological processes in he atmosphere.

Excerpt

The presented evidence that swarming, migrating insects transport charge in the lower atmosphere indicates that large collections of charged insects will contribute to a hitherto unrecognized source of electrical variability in the atmosphere. This recognition potentially carries various physically- and biologically relevant implications. For instance, entomogenic space charge is not considered in current climate models aimed at capturing the complex interplay between radiation and particulate matter, such as the atmospheric transport of dust. As atmospheric space charge enhances the aggregation and movement of aerial particles (Toth et al., 2020), it is conceivable that insect-derived space charges will also contribute to spatial changes in aerial particles. For example, it could be speculated that insect-driven charged particle collection and transport could contribute to long-range transport of desert dust, providing alternative explanations for the transport of large particles, which cannot be explained by physical processes alone (Toth et al., 2020; Does Van

der et al., 2018). Further, insects are not the only source of biogenic charge in the atmosphere, as birds and microorganisms also carry charge and abound in the lower atmosphere (Badger et al., 2015; de Groot et al., 2021). The observed presence and magnitude of biogenic space charge invites further interdisciplinary research into the dynamic electrical interactions between physical and biological entities in the atmosphere.
Open access paper: https://www.cell.com/iscience/fulltext/S2589-0042(22)01513-9

SCIENTIFIC EVIDENCE INVALIDATES HEALTH ASSUMPTIONS UNDERLYING THE FCC AND ICNIRP EXPOSURE LIMIT DETERMINATIONS FOR RADIOFREQUENCY RADIATION: IMPLICATIONS FOR 5G

International Commission on the Biological Effects of Electromagnetic Fields. Scientific evidence invalidates health assumptions underlying the FCC and ICNIRP exposure limit determinations for radiofrequency radiation: implications for 5G. Environmental Health. (2022) 21:92. doi.org:10.1186/s12940-022-00900-9.

Abstract

In the late-1990s, the FCC and ICNIRP adopted radiofrequency radiation (RFR) exposure limits to protect the public and workers from adverse effects of RFR. These limits were based on results from behavioral studies conducted in the 1980s involving 40–60-minute exposures in 5 monkeys and 8 rats, and then applying arbitrary safety factors to an apparent threshold specific absorption rate (SAR) of 4 W/kg. The limits were also based on two major assumptions: any biological effects were due to excessive tissue heating and no effects would occur below the putative threshold SAR, as well as twelve assumptions that were not specified by either the FCC or ICNIRP. In this paper, we show how the past 25 years of extensive research on RFR demonstrates that the assumptions underlying the FCC's and ICNIRP's exposure limits are invalid and continue to present a public health harm. Adverse effects observed at exposures below the assumed threshold SAR include non-thermal induction of reactive oxygen species, DNA damage, cardiomyopathy, carcinogenicity, sperm damage, and neurological effects, including electromagnetic hypersensitivity. Also, multiple human studies have found statistically significant associations between RFR exposure and increased brain and thyroid cancer risk. Yet, in 2020, and in light of the body of evidence reviewed in this article, the FCC and ICNIRP reaffirmed the same limits that were established in the 1990s. Consequently, these exposure limits, which are based on false suppositions, do not adequately protect workers, children, hypersensitive individuals, and the general population from short- term or long-term RFR exposures. Thus, urgently needed are health protective exposure limits for humans and the environment. These limits must be based on scientific evidence rather than on erroneous assumptions, especially given the increasing worldwide exposures of people and the environment to RFR, including novel forms of radiation from 5G telecommunications for which there are no adequate health effects studies.

Key points

- ICBE-EMF scientists report that exposure limits for radiofrequency (or wireless) radiation set by ICNIRP and the FCC are based on invalid assumptions and outdated science, and are not protective of human health and wildlife.

- ICBE-EMF calls for an independent assessment of the effects and risks of radiofrequency radiation based on scientific evidence from peer-reviewed studies conducted over the past 25 years. The aim of such assessment would be to establish health protective exposure standards for workers, the public, and the environment.
- The public should be informed of the health risks of wireless radiation and encouraged to take precautions to minimize exposures, especially for children, pregnant women and people who are electromagnetically hypersensitive.
- ICBE-EMF calls for an immediate moratorium on further rollout of 5G wireless technologies until safety is demonstrated and not simply assumed.

Open access paper: https://ehjournal.biomedcentral.com/articles/10.1186/s12940-022-00900-9

IT IS MANDATORY TO REVIEW ENVIRONMENTAL RADIOFREQUENCY ELECTROMAGNETIC FIELD MEASUREMENT PROTOCOLS AND EXPOSURE REGULATIONS: AN OPINION ARTICLE

Lopez I, Rivera M, Feliz N, Maestu C. It is mandatory to review environmental radiofrequency electromagnetic field measurement protocols and exposure regulations: An opinion article. Front. Public Health, 24 October 2022. Sec. Radiation and Health. doi: 10.3389/fpubh.2022.992645

Excerpts

"According to the International Telecommunication Union (ITU) World Telecommunication/ICT Indicators Database in 2004 there were 1.76 billion mobile phone subscriptions in the world, in 2020 this figure increased to 8.27 billion (1). By 2023, there are expected to be 13.1 billion mobile terminals, almost 10% of which will be 5G technology (2)."

"Several scientific studies evaluate the possible effects of prolonged exposure to microwaves at the epidemiological level (4–11) and in vitro or in vivo models (12–19). However, the use of different methodologies in radiation measurement processes and different configurations of exposure equipment, such as frequency, radiation power density, and exposure time; do not allow adequate comparison of results, which makes it difficult to draw conclusions."

" Although most countries such as Spain, Germany, France or Finland adopt the limits proposed by the ICNIRP, the existing regulations in other are different, with limits more restrictive in countries such as Denmark, Bulgaria, Italy, Switzerland, China or Russia (21–23)."

"Old standards and measurement methodologies are not adapted to the new communications standards and technologies"

"Underestimation of non-thermal effects in the development of measurement methodologies"

"Many researchers consider the choice of the SAR criterion as the only parameter for assessing effects on biological systems as insufficient, as it only takes into account the thermal effects resulting from exposure (48– 50). The ICNIRP guidelines state that a one Celsius degree increase in body temperature is the acceptable limit to avoid adverse health effects (20). Although a reduction factor of 50 is applied to the SAR value capable of increasing the temperature by 1°C, no account is taken of other effects not related to temperature increase.

These effects, have been reported in numerous in vitro and in vivo studies to occur at lower intensities than those required to cause thermal effects by low and high frequency EMFs, such as alterations in gene expression (51, 52), oxidation processes (12, 14, 19, 53–56), the flow of calcium ions (57–59), proteins (60) or cell viability(13, 17)."

"The studies assessing the possible effects of RF-EMFs in vitro should consider all important parameters in the exposure: intensity, frequency, modulation and time of exposure. The possible existence of bioactive windows in frequency, intensity or modulation, as well as the non-linear response of biological systems that could produce differences in cellular behavior should be considered in the development of measurement methodologies and the establishment of exposure limits and could serve as a precedent to establish mechanisms of action of these RF-EMFs in relation to biological systems."

"In conclusion, two main ideas arise: the review of the environmental EMFs measurement protocols and the need for a comprehensive assessment of all the effects of EMFs not only thermal effects.

Measurement protocols must identify the specific frequencies of each of the currently established major frequency bands, the temporal behavior of the signal and the power density. Measurement systems must not only determine averaged field strengths but must be able to measure the peak amplitude over time and, consequently, the cumulative radiation. This would make the characterization of EMFs much more realistic.

In addition, parameters such as frequency and modulation could be important when considering potential biological effects. Choosing intensity as the only determining parameter for the occurrence of effects is a reductionist conception. The consideration of all EMFs parameters in the assessment of biological response should be mandatory."

Open access paper: https://www.frontiersin.org/articles/10.3389/fpubh.2022.992645/full

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CARCINOGENESIS FROM CHRONIC EXPOSURE TO RADIO-FREQUENCY RADIATION

James C. Lin. Carcinogenesis from chronic exposure to radio-frequency radiation. Front. Public Health, Sec. Radiation and Health. 31 October 2022. doi: 10.3389/fpubh.2022.1042478.

Abstract

The past two decades have seen exponential growth in demand for wireless access that has been projected to continue for years to come. Meeting the demand would necessarily bring about greater human exposure to microwave and radiofrequency (RF) radiation. Our knowledge regarding its health effects has increased.

Nevertheless, they have become a focal point of current interest and concern. The cellphone and allied wireless communication technologies have demonstrated their direct benefit to people in modern society. However, as for their impact on the radiation health and safety of humans who are unnecessarily subjected to various levels of RF exposure over prolonged durations or even over their lifetime, the jury is still out. Furthermore, there are consistent indications from epidemiological studies and animal investigations that RF exposure is

probably carcinogenic to humans. The principle of ALARA—as low as reasonably achievable—ought to be adopted as a strategy for RF health and safety protection.

Excerpts

"Recently, two commonly distributed RF health protection recommendations revised their guidelines and standards. The updated International Commission on Nonionizing Radiation Protection guidelines (5) and Institute of Electrical and Electronic Engineers International Committee on Electromagnetic Safety standards (6) are strongly connected to acute temperature rises induced by RF heating inside the human body. The updated safety guidelines and standards showed without any question the groups' staunch convictions of nothing but heat to worry about with microwave and RF radiation.

A persistent and vexing question lingers concerning these guidelines and standards for safe long-term exposure to RF radiation (in contrast to exposures shorter than 6 or 30 min). A general sense on the absence of appreciation of scientific evidence regarding long-term exposure below the basic restrictions continues with these safety guidelines and standards.

There is also the question of how there can be such divergent evaluations and inferences of the identical scientific findings by WHO's IARC, ICES, and ICNIRP. To be fair, scientists are not impervious to conflicts of interest such as conflicting financial interests or personal relations which could affect the deliberations and reporting through such experiences as groupthink. Also, in some ways, it may parallel the compulsion by big business to choose profit over societal concerns—big businesses often use a range of organized and refined tactics to enhance and protect their commercial interests, and regrettably in some cases these tactics come at the expense of public health.

Human beings repeatedly render decisions and select choices that challenge principled logic. Indeed, science has not been devoid of politics—weird as that may sound. Various biases can impair sensible reasoning and result in bad judgments. Groupthink can mislead human beings and inhibit scientists from making understandable inferences. Regrettably, groupthink or herd mentality is as rampant today as ever. Has science become partisan? And if science becomes partisan, is it science or politics, or would it be political science? At times, science gets wrapped up in politics and politics intervenes with science. It may simply turn out to be a matter of guilelessly being politically correct of the willing. Less than rigorous enforcement of policies in research conduct or full disclosure of financial conflicts can lead to failures in guiding and informing the development of transparent and trustworthy evaluations of scientific evidence for safety protection. Scientists may not always be consistent, coherent, or as transparent as promoted."

"The fact is that the missing pieces according to IARC [the WHO International Agency for Research on Cancer] (4), or the previously coveted experimental animal data (7) as currently provided by NTP/NIEHS (10) and Ramazzini Institute (12) complement IARC's evaluation of human epidemiological studies in support of its classification of RF radiation as a possible carcinogen. It gives rise to the plausibility for IARC to enhance its previous, mostly epidemiology-based classification to the higher level of “probably cancer causing” for RF exposure.

Furthermore, more recent systematic reviews and meta-analyses of the case-control research on mobile phone use have reported statistically significant increases in brain tumor risk associated with 1,000 or more hours of cellphone use, or about 17 min per day over 10 years (13, 14)."

"The simple and effective public health notion of 'An ounce of prevention is better than a pound of cure' may conjure up old fashioned. It may arouse intense reactions, with enormous defiance especially from individuals who may be beneficiary of modern promotions. The cellphone and allied wireless communication technologies have shown their direct benefit to people in modern society. However, as for their impact on the radiation health and safety of humans who are subjected unnecessarily to various levels of RF exposure over prolonged durations or even over their lifetime, the jury is still out. Furthermore, there are consistent indications from epidemiological studies and animal investigations that RF exposure is, at least, probably carcinogenic to humans. The principle of ALARA—as low as reasonably achievable—ought to be adopted as a strategy for RF health and safety protection."

Open access paper: https://www.frontiersin.org/articles/10.3389/fpubh.2022.1042478/full

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THE LACK OF INTERNATIONAL AND NATIONAL HEALTH POLICIES TO PROTECT PERSONS WITH SELF-DECLARED ELECTROMAGNETIC HYPERSENSITIVITY

Leszczynski D. The lack of international and national health policies to protect persons with self-declared electromagnetic hypersensitivity. Rev Environ Health. 2022 Oct 26. doi: 10.1515/reveh-2022-0108.

Abstract

Electromagnetic hypersensitivity (EHS), known also as an idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF) or a microwave sickness, is not considered by the World Health Organization (WHO) as being caused by the exposures to electromagnetic fields (EMF). EHS is not recognized as a disease anywhere in the world. Some studies have roughly estimated that 1-10% of the population might experience some form of EHS. However, because of the lack of diagnostic criteria for EHS, these estimates might be either under- or over-estimates. Because the vast majority of human population is exposed to EMF, the possibility of developing EHS from the EMF is a substantial public health issue that should be dealt with globally, even if the individual risk of developing EHS might be small. The WHO recognizes that the symptoms experienced by the EHS persons might be severe and might significantly hamper everyday life. However, after a broad analysis of international and national documents, there seems to be currently no effort to develop health policies for EHS, no matter what causes it. National governments, follow the opinions of the WHO and the EMF safety standards setting organizations, the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the Institute of Electrical and Electronics Engineers - International Committee on Electromagnetic Safety (IEEE-ICES), are not developing any practical health policy advisories for self-declared EHS sufferers. However, symptoms experienced by the self-declared EHS persons affect their well-being and, according to the Constitution of the WHO, are a health problem. Hence, independently of what causes EHS symptoms, this admitted well-being- impairment should be dealt with globally by developing an uniform health policy. Furthermore, WHO, ICNIRP and IEEE-ICES should be advocating and supporting research that would generate reliable scientific evidence on what are the possible

cause(s) of EHS. Without such research it is not possible to develop diagnostic methods as well as any possible mitigation approaches. There is an urgent need for the WHO to advocate for the national governments to urgently develop a comprehensive and common EHS health policy.

Open access paper: https://www.degruyter.com/document/doi/10.1515/reveh-2022-0108/html

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COMPARISON OF MOBILE PHONE USAGE AND PHYSICAL ACTIVITY ON GLYCEMIC STATUS, BODY COMPOSITION & LIFESTYLE IN MALE SAUDI MOBILE PHONE USERS

Al-Khlaiwi T, Habib SS, Alshalan M, Al-Qhatani M, Alsowiegh S, Queid S, Alyabis O, Al-Khliwi H. Comparison of mobile phone usage and physical activity on glycemic status, body composition & lifestyle in male Saudi mobile phone users. Heliyon. 2022 Sep 15;8(9):e10646. doi: 10.1016/j.heliyon.2022.e10646.

Abstract

Background & Objectives: This study aimed to compare the effects of mobile phone usage and physical activity on HbA1c, body composition, and lifestyle among male Saudi Arabian mobile phone users.

Methods: The study was conducted in the Department of Physiology, College of Medicine, King Saud University, Riyadh, Saudi Arabia from July 2020 to July 2021. The study sample consisted of 203 non-smoker male Saudi participants aged from 20 to 60 years who used mobile phones. Personal information was obtained through interviews using a proforma. The participants were divided into three groups according to their daily mobile phone usage: Group (1): less than 2 h, Group (2): 2-3 h, and Group (3): more than 3 h, and according to their physical activities: Group (1): sedentary, Group (2): average, and Group (3): athletes. Glycated Hemoglobin (HbA1c), Bioelectrical Impedance Analysis (BIA), and (SF) 36- items survey was performed.

Results: The mean age of 203 Saudi male adult participants was 28.0 ± 10.4 years. Mobile phone usage in the less than 2 h group was (33.5%), between 2-3 h (22.7%), and more than 3 h (43.8%) respectively. The mean age of Group (3), who used mobile phones for more than 3 h, was the lowest (23.9 ± 5.7). The results showed that HbA1C levels were almost equal in all three groups (5.8 ± 0.4, 5.7 ± 0.4, and 5.7 ± 0.3 respectively). In addition, emotional well-being and social functioning showed insignificant decreases in the more than 3 h group compared to other groups of mobile phone usage (69.3 ± 15.7, 70.9 ± 15.5, 65.2 ± 16.0, p = .091 and 82.9 ± 201, 81.2 ± 18.7, 77.6 ± 21.6, p = .267) respectively. No effect was detected between groups regarding various body compositions. Regarding physical activity classifications: the sedentary group constituted (36%) of the sample, whereas the average and athlete groups represented (53.7%) and (10.3%) of the total sample respectively. There was a significant decrease in BMI (29.6 ± 7.8, 25.3 ± 5.1,24.7 ± 5.6, p = .000), fat mass (24.7 ± 15.0, 17.1 ± 9.1, 15.3 ± 10.6, p = .000), and free fat mass (64.0 ± 10.2, 56.8 ± 8.7, 57.5 ± 8.0, p = .000) in the average and the athletic groups compared to the sedentary group. No significant difference was found in HbA1c between physical activity groups (5.8 ± 0.4, 5.7 ± 0.4, 5.7 ± 0.4, p = .218).

Conclusions: Mobile phone usage does not affect HbA1c and body composition parameters. Furthermore, we found the youngers used mobile phones longer than others. Insignificant

decrease in emotional well-being and social functioning parameters of the style of life due to long mobile phone usage which needs more attention.

Conclusions and Recommendations

We concluded that mobile phone usage does not affect HbA1c and body composition parameters. Also, youngers were found to use mobile phones more than others. This should increase public awareness about the long usage of mobile phones among society members. More attention should be directed toward teenagers to eliminate the effects of mobile phones on emotions and social functioning. Further study on a large sample size including different age groups, long mobile phone usage, and female gender is highly recommended. The effect of mobile phone usage on visceral fat is of great value to be studied. A well-controlled study that compares differences in the frequency of radiation, exposure time, distance from the source of the radiation, and its effects on age should be carried out, supported, and funded to evaluate the exact effect of Electromagnetic Field Radiation.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9489969/

MOBILE PHONE INDUCED EMF STRESS IS REVERSED UPON THE USE OF PROTECTIVE DEVICES: RESULTS FROM TWO EXPERIMENTS TESTING DIFFERENT BOUNDARY CONDITIONS

Schneider R. Mobile phone induced EMF stress is reversed upon the use of protective devices: results from two experiments testing different boundary conditions. Electromagn Biol Med. 2022 Oct 3:1-10. doi: 10.1080/15368378.2022.2129380.

Abstract

This work examines (a) the impact of electromagnetic fields (EMF) on heart rate variability (HRV), saliva cortisol, arterial blood oxygenation, and tympanic temperature, and (b) the potential effect of protective devices developed to counter EMF-induced stress. In a pilot study, recordings were taken during a 15-min mobile phone call emitting a high burden of EMF (electric, magnetic, high frequency) after a baseline measurement at rest with very low EMF. In a second visit, this was repeated with participants using three protective devices (insoles, pendant, mobile phone chip). In the main study, four experimental arms were employed, two of which replicated the experimental setup of the pilot study, and two of which examined the effect of only one mobile phone chip in an open-hidden-paradigm. In both experiments, exposure to EMF decreased HRV and increased salivary cortisol. In the protective experimental condition, HRV increased above and cortisol decreased below the level of the baseline measures. All differences were large and specific and not modulated by non-specific effects like placebo effects.

Excerpts

Study 1 (Pilot Study): The sample consisted of N = 6 subjects (three females) who were on average 31 years old (22–46 years).

Study 2: Based on the effect size of HRV (RMSSD) found in the pilot study, the sample size of each experimental group was set at n = 15 to achieve a power of 1- $\beta \geq .95$ (Faul et al. 2009). In total, 60 participants (28 females) were enrolled in study 2. Their mean age was 37.6 years (SD = 13.9).

Conclusion
The use of mobile phones induces physiological stress on a neurocardiac and neuroendocrine level after a short exposure time of 15 minutes. These physiological stress responses can be offset with specially designed protected devices. The technology tested (EssenceX shungite) produces a 'super-optimization' of HRV and cortisol inhibition exceeding normoregulation in non-stressful conditions. These results encourage further investigation of long-term effects of this technology in different environments. https://pubmed.ncbi.nlm.nih.gov/36189775/

TIME COURSE OF HEALTH COMPLAINTS ATTRIBUTED TO RF-EMF EXPOSURE AND PREDICTORS OF ELECTROMAGNETIC HYPERSENSITIVITY OVER 10 YEARS IN A PROSPECTIVE COHORT OF DUTCH ADULTS

Eugenio Traini, Astrid L. Martens, Pauline Slottje, Roel C.H. Vermeulen, Anke Huss. Time course of health complaints attributed to RF-EMF exposure and predictors of electromagnetic hypersensitivity over 10 years in a prospective cohort of Dutch adults. Science of The Total Environment. 2022. doi:10.1016/j.scitotenv.2022.159240.

My note: This study seems methodologically flawed. I think the assessment of IEI-RFin this study was invalid as the results at T4 make no sense -- at T4, 12.4% (108 of 892) reported being electromagnetic hypersensitive but only 1.2% (11 of 892) reported having symptoms which they attributed to RF exposure (i.e.they were classified as IEI-RF). However, in order to be classified as IEI-RF, one first had to answer affirmatively to the question, "Do you currently have health complaints that you attribute to the environment," before responding to several RF- specific questions. I think most people who self-reported as EHS failed to answer this screener question affirmatively because the question is confusing.

Highlights

- Time course of attribution of health complaints to RF-EMF exposure.
- Predictors of electromagnetic hypersensitivity.
- Multi-state Markov models to represent how individuals in the cohort transition between states of attribution of health complaints to RF-EMF exposure.
- Attribution of health complaints to RF-EMF exposure appears to be a more transient condition than previously assumed.

Abstract

Background Some individuals attribute health complaints to radiofrequency electromagnetic field (RF-EMF) exposure. This condition, known as idiopathic environmental intolerance attributed to RF-EMFs (IEI-RF) or electromagnetic hypersensitivity (EHS), can be disabling for those who are affected. In this study we assessed factors related to developing, maintaining, or discarding IEI-RF over the course of 10 years, and predictors of developing EHS at follow-up using a targeted question without the condition of reporting health complaints attributed to RF-EMF exposure.

Methods Participants (n = 892, mean age 50 at baseline, 52 % women) from the Dutch Occupational and Environmental Health Cohort Study AMIGO filled in questionnaires in 2011/2012 (T0), 2013 (T1), and 2021 (T4) where information pertaining to perceived RF-EMF exposure and risk, non-specific symptoms, sleep problems, IEI-RF, and EHS was collected. We

fitted multi-state Markov models to represent how individuals transitioned between states ("yes", "no") of IEI-RF.

Results At each time point, about 1 % of study participants reported health complaints that they attributed to RF-EMF exposure. While this percentage remained stable, the individuals who reported such complaints changed over time: of nine persons reporting health complaints at T0, only one reported IEI-RF at both T1 and T4, and two newly reported health complaints at T4. Overall, participants had a 95 % chance of transitioning from "yes" to "no" over a time course of 10 years, and a chance of 1 % of transitioning from "no" to "yes". Participants with high perceived RF-EMF exposure and risk had a general tendency to move more frequently between states.

Conclusions We observed a low prevalence of IEI-RF in our population. Prevalence did not vary strongly over time but there was a strong aspect of change: over 10 years, there was a high probability of not attributing symptoms to RF-EMF exposure anymore. IEI-RF appears to be a more transient condition than previously assumed.
Open access paper: https://www.sciencedirect.com/science/article/pii/S0048969722063392

A CROSS-SECTIONAL STUDY ON SMARTPHONE USES AMONG PREGNANT WOMEN ATTENDING CHILDBIRTH CLASSES IN THE METROPOLITAN AREA OF PALERMO, ITALY: THE STOP-PHONE STUDY

Costantino C, Mazzucco W, Bonaccorso N, Sciortino M, Cimino L, Pizzo S, Conforto A, Calò I, Giliberti D, Gambino CR, Segreto D, Maiorana A, Vitale F, Casuccio A. A cross-sectional study on smartphone uses among pregnant women attending childbirth classes in the Metropolitan Area of Palermo, Italy: The Stop-Phone study. Ann Ig.2022 Sep 29. doi: 10.7416/ai.2022.2543.

Abstract

Background: Prevalence of mobile device addiction has increased over the years; both women and men have assimilated the mobile phone as a central component of their personal existence: integrating it into their lifestyle or becoming so dependent on it that life without it has become unimaginable. Smartphones generate radio-frequency electromagnetic fields. While short-term exposure in adults was considered quite safe, effects of long-term exposure or exposure during pregnancy on fetuses or during breastfeeding on newborns are not well studied yet. The objective of the present study was to investigate the prevalence and usage characteristics of smartphones among a sample of pregnant women, and promote the correct and conscious use of the smartphone.

Methods: A cross-sectional study was conducted, with a questionnaire administered during childbirth classes and - after the questionnaire administration - an educational intervention focused on promoting the correct and conscious use of smartphones was carried out by psychologists and psychotherapists.

Results: The findings of our study suggest that a significant number of the participants suffered addiction to mobile phone usage, but were not aware of it. More than two third of the sample (67.2%) have not changed their smartphone use habits since the beginning of their

pregnancy and even more significant data shows that almost all future moms (98.3%) never speak with their doctor about smartphone use during pregnancy.

Conclusions: Data collected suggest a lack of attention to the proposed topic, especially in relation to pregnancy. It seems necessary to sensitize future mothers on this topic. The promotion of a more conscious and controlled use of electronic devices can help reduce the radiation to which the unborn child may be exposed, but has a fundamental role even after birth, to ensure an adequate psychomotor and relational development of the child and do not affect, due to uncontrolled use of smartphones, the mother-child relationship.

Open access paper:
https://annali-igiene.it/articoli/2022/online_ahead_of_print/09/Costantino.pdf

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ASSESSMENT OF INCIDENT POWER DENSITY IN DIFFERENT SHAPES OF AVERAGING AREA FOR RADIO-FREQUENCY EXPOSURE ABOVE 6 GHZ

Morimoto R, Hirata A.Phys Med Biol. 2022;67(21):10.1088/1361-6560/ac994d. Published 2022 Oct 31. doi:10.1088/1361-6560/ac994d.

Abstract

Objective - The International Commission on Non-Ionizing Radiation Protection guidelines and IEEE C95.1-2019 standard for human protection from local electromagnetic field exposure above 6 GHz state that absorbed (or epithelial) power density (APD) and incident power density (IPD), averaged over a square area, are internal and external physical quantities, respectively, that set the exposure limit. Per exposure standards, the measurement procedure and evaluation of the IPD have been established in technical standards, where a circular averaging area is recommended only for non-planar surfaces in IEC/IEEE 63195-1 and -2. In this study, the effects of two averaging shapes on the APD and IPD are evaluated computationally to provide new insights from the viewpoint of exposure standards.

Approach- The relation between the APD, IPD, and the steady-state temperature rise (heating factor) in rectangular and human models for exposure to a single dipole, dipole arrays, and the Gaussian beams is investigated computationally with finite-difference method.

Main results - The maximum differences in the heating factor of the APD and IPD for square and circular averaging areas were 4.1% and 4.4% for the antenna-model distance >5 mm, respectively. These differences appear when the beam pattern on the model surface has an elliptical shape. For an antenna-model distance ≤5 mm and at frequencies ≤15 GHz, the heating factors for square averaging areas were not always conservative to those for circular ones (-7.8% for IPD), where only the antenna feed point are visible before beam formation.

Significance - The heating factors of the APD and IPD for a circular averaging area are conservative for near-field exposure of canonical sources for frequencies up to 300 GHz, except for a beam with a significant major-to- minor axis ratio and an angle of 30°-60° to a square averaging area. This tendency would help bridge the gap between exposure and product standards.

Open access paper: https://iopscience.iop.org/article/10.1088/1361-6560/ac994d/pdf

ON RADAR AND RADIO EXPOSURE AND CANCER IN THE MILITARY SETTING

Peleg M, Berry EM, Deitch M, Nativ O, Richter E. On radar and radio exposure and cancer in the military setting. Environ Res. 2022 Oct 21:114610. doi: 10.1016/j.envres.2022.114610.

Abstract

Introduction: In 2018, we reported a case series of 47 patients diagnosed with cancer following several years of exposure to high-intensity whole-body radiofrequency radiation (RFR) using the parameter of percentage frequency (PF). Consistent high and statistically significant PFs of hematolymphoid (HL) cancers were found in this group and in four previous reports on RFR-exposed groups in Belgium, Poland and Israel together with increased all-cancers rates. In this paper we report a new series of 46 young cancer patients who were exposed during military service to such radiation.

Materials and methods: The new group of patients comprises Israeli soldiers previously exposed to occupational RFR. The patients were self-selected to enroll in the research in cooperation with an NGO assisting patients with administrative counseling and legal and social services. The new group of patients was studied with respect to distribution (proportion) of cancer types using the method of PF. When possible, cancer risk ratios (RR) were estimated too. The results are compared to those of other occupational groups in three countries.

Results: Median age at diagnosis was 23 years; duration of exposure was between 1 and 3 years and the latencies were short, median 4.6 years. The PF of HL cancers was 41.3%, 95% CI (27%-57%), versus 22.7% expected in non-exposed subjects matched for age and gender profiles, $p = 0.003$; 19 out of the 46 patients had HL cancers. The PF of Hodgkin lymphoma cancers was 21.7%, 95%CI (11%-36%), versus 11.6% expected, $p =0.033$. For a subgroup of 6 patients, the number of soldiers in the units was known, and we were able estimate approximately the overall cancer risk ratio (RR) after 8 years as being 8.0 with 95% CI (2.9, 17), $p < 0.002$, with only 0.75 cases expected from the Cancer Registry data. In this subgroup, there were 3 HL cancer cases and 3 non-HL cases. Sarcoma PF was higher than expected, 7 out of the 46 patients were diagnosed with sarcoma, PF = 15.2%, 95%CI (6.3%-28.9%), $p = 0.04$ versus the expected PF of 7%.

Conclusions: The HL PF was high and consistent with previous reports. Epidemiological studies on excess risk for HL and other cancers, brain tumors in cellphone users, and experimental studies on RFR and carcinogenicity strongly point to a cause-effect relationship. It is mandatory to reduce the RFR exposure of all personnel to that of the typical community levels, including the peak level of radar pulses. Radiation protection, safety instructions, cancer risk warnings and quantitative data on individual exposure together with regular medical monitoring must be instituted for all personnel exposed to such risks. The findings from our study add to the growing body of evidence underscoring the gross inadequacy of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) thermal standards. Based on our findings and on the previous accumulated research, we endorse the recommendations to reclassify RFR exposure as a human carcinogen, International Agency for Research on Cancer (IARC) group 1.

https://www.sciencedirect.com/science/article/abs/pii/S0013935122019375

HYGIENIC PROBLEMS OF USING INFORMATION AND COMPUTER TECHNOLOGY DEVICES BY CHILDREN

Grigoriev O.A. Hygienic problems of using information and computer technology devices by children. Hygiene and Sanitation. 2022;101(10):1214-1222. (In Russ.) https://doi.org/10.47470/0016-9900-2022-101-10-1214- 1222 (The paper is published in Russian.)

Abstract

There was carried out the analysis of information and computer technologies (ICT), which are the main hygienically significant sources of non-ionizing electromagnetic radiation for children and adolescents. Early forecasts (before 2008) about the adverse impact of the ICT electromagnetic field on the health of children and adolescents, the fundamental scientific basis for forecasts and data on their feasibility to date are considered. According to state statistics, forecasts of an increase in morbidity due to EMF exposure to children and adolescents are likely to come true. For the period 1995-2019, 15-17 years children, a steady trend was identified for the gain in cerebral malignant neoplasms, diseases of the nervous system, blood, hematopoietic organs, and individual disorders involving the immune mechanism. The number of recorded malignant neoplasms of the brain in the adolescent contingent allows performing for the first time "case-control" analysis. Uncertainties in assessing the conditionality of the increase in the incidence in children under the influence of non-ionizing ICT electromagnetic radiation are associated with difficulties in determining personal doses. The limits of EMF exposure of the user's head by a mobile device, which were developed in 1994, are now outdated and it is necessary to change the limits, as the devices and parameters of exposure to non-ionizing electromagnetic radiation of ICT have changed. It is necessary to confirm the reliability of the hygienic safety factor of EMF remote control in relation to children's contingents in the conditions of modern and promising information and computer technologies, including taking into account possible synergy under the action of radio frequency EMF, optical screen radiation, sound effects and functional load. Obviously, today what is required is an integrated approach to ensuring the health of children "hygiene in the digital environment". The article substantiates the foreign standards to affect the design and equipment for information and communication technologies of the educational environment in the Russian Federation, which is one of the important reasons for the deterioration of children's health. https://www.rjhas.ru/jour/article/view/2596

EFFECTS OF COMBINED EMF EXPOSURES AND CO-EXPOSURES

Mattsson Mats-Olof, Simkó Myrtill, Scarfi Maria Rosaria, Zeni Olga. Editorial: Effects of combined EMF exposures and co-exposures, volume II. Frontiers in Public Health. 10, 2022. doi: 10.3389/fpubh.2022.1052639.

Conclusions

In summary, the papers presented in this special issue represent a diverse account of the complex exposure situation around specific devices due to combinations of static MF, IF-EMF, and RF-EMF in occupational settings. Since this topic deserves great attention for the purpose of exposure assessment of relevance for compliance with exposure limits and for its central role within the process of health risk assessment, we hope that the readers can find these articles informative and useful to perform ground-breaking research in this area.

The collection is also adding relevant evidence to the question of possible effects on reproduction from exposures to RF EMF at levels below generally recognized exposure limits. Strikingly, such studies are by far lacking combinatorial or co-exposure components.
https://www.frontiersin.org/articles/10.3389/fpubh.2022.1052639

PERSONAL EXPOSIMETER COUPLED TO A DRONE AS A SYSTEM FOR MEASURING ENVIRONMENTAL ELECTROMAGNETIC FIELDS

García-Cobos FJ, Paniagua-Sánchez JM, Gordillo-Guerrero A, Marabel-Calderón C, Rufo-Pérez M, Jiménez-Barco A. Personal exposimeter coupled to a drone as a system for measuring environmental electromagnetic fields. Environ Res. 2022 Oct 6:114483. doi: 10.1016/j.envres.2022.114483.

Highlights

- The wireless remote controller does not alter the bands of interest.
- The structure of the drone affects the measurements in a quantifiable way.
- Vertical electric field profile consistent with the antenna height and downtilt.
- The attenuation of a building is estimated.

Abstract

Personal exposimeters are currently used in studies assessing human exposure to electromagnetic fields. These devices are usually carried by an individual, but vehicles such as bicycle or car are also used. The aim of the present study was to propose a personal exposimeter attached to a drone to perform environmental radio- frequency measurements. Trials were carried out to determine whether: (i) the wireless communication between the remote controller and the drone affects the downlink mobile telephony bands by a cross-talk effect, and (ii) the structure of the drone alters the measurements of the exposimeter compared to when the meter is on a tripod. To apply this system to a real scenario, a 3D representation of the electric field in a building was obtained, and the attenuation due to the building of radiation from outside was estimated. Measurements of the electromagnetic field with this system will make it possible to monitor without risk the emissions of antennas in their close vicinity, and to validate propagation models experimentally.

Open access paper:
https://www.sciencedirect.com/science/article/pii/S0013935122018102?via%3Dihub

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EFFECTS OF 3.5 GHZ RADIOFREQUENCY RADIATION ON GHRELIN, NESFATIN-1, AND IRISIN LEVELS IN DIABETIC AND HEALTHY BRAINS

Bektas H, Algul S, Altindag F, Yegin K, Akdag MZ, Dasdag S. Effects of 3.5 GHz radiofrequency radiation on ghrelin, nesfatin-1, and irisin level in diabetic and healthy brains. J Chem Neuroanat. 2022 Oct 8;126:102168. doi: 10.1016/j.jchemneu.2022.102168.

Abstract

Diabetes, mobile phone use, and obesity have increased simultaneously in recent years. The radiofrequency radiation (RFR) emitted from mobile phones is largely absorbed in the heads of users. With 5 G, which has started to be used in some countries without the necessary precautions being taken, the amount of RFR to which living things are exposed will increase. In this study, the changes in energy homeostasis and redox balance caused by 5 G (3.5 GHz,

GSM-modulated) were explored. The effects of RFR on the brains of diabetic and healthy rats were investigated and histopathological analysis was performed. Twenty-eight Wistar albino rats weighing 200-250 g were divided into 4 groups as sham, RFR, diabetes, and RFR+diabetes groups (n = 7). The rats in each group were kept in a plexiglass carousel for 2 h a day for 30 days. While the rats in the experimental groups were exposed to RFR for 2 h a day, the rats in the sham group were kept under the same experimental conditions but with the radiofrequency generator turned off. At the end of the experiment, brain tissues were collected from euthanized rats. Total antioxidant (TAS), total oxidant (TOS), hydrogen peroxide (H2O2), ghrelin, nesfatin-1, and irisin levels were determined. In addition, histopathological analyses of the brain tissues were performed. The specific absorption rate in the gray matter of the brain was calculated as 323 mW/kg and 195 mW/kg for 1 g and 10 g averaging, respectively. After RFR exposure among diabetic and healthy rats, decreased TAS levels and increased TOS and H2O2 levels were observed in brain tissues. RFR caused increases in ghrelin and irisin and a decrease in nesfatin-1 in the brain. It was also observed that RFR increased the number of degenerated neurons in the hippocampus. Our results indicate that 3.5 GHz RFR causes changes in the energy metabolism and appetite of both healthy and diabetic rats. Thus, 5 G may not be innocent in terms of its biological effects, especially in the presence of diabetes. https://pubmed.ncbi.nlm.nih.gov/36220504/

EFFECT OF SHORT-TIME EXPOSURE OF LOCAL EXTREMELY LOW-FREQUENCY MAGNETIC FIELDS ON SLEEPINESS IN MALE RATS

Azizi E, Ayoobi F, Shamsizadeh A, Moghadam-Ahmadi A, Shafiei S A, Khoshdel A et al. BCN 2022; 13 (4) :519- 530.

Abstract

Introduction: Lack of high-quality sleep causes severe side effects like anxiety and changes in plasma concentration of oxalate. The current study investigated the impact of local extremely low-frequency magnetic fields (ELF-MFs) on inducing sleep (sleepiness) and anxiety in male rats.

Methods: In this experimental study, 40 male rats were divided into four groups (n=10 for each group). The ELF- MF exposure (0, 10, and 18 Hz) was applied with an intensity of 200µT for three days (10 min/d). The sham- treated animal did not receive ELF-MF. Serum levels of oxalic acid (OA) and sleepiness were measured before and after the last exposure to ELF-MF or sham. Anxiety, sleepiness, and OA were measured using the elevated plus maze, open-field test (OFT), and ELISA test.

Results: A comparison of oxalate levels before and after exposure to ELF-MF revealed that ELF-MF (10 Hz) decreased the serum level of oxalate ($P<0.05$). Comparing open/closed arm entry (in an elevated plus maze) between before and after exposure to ELF-MF revealed significant differences. Also, frequency, velocity, and distance moved were decreased in the open-field test.

Conclusion: Results of the present study demonstrated that ELF-MF with short-time exposure may modulate the metabolism of OA and may modulate anxiety-like behavior or kind of induction of sleepiness in male rats.

Open access paper: http://bcn.iums.ac.ir/article-1-1805-en.html

MEASUREMENT OF INTERMEDIATE FREQUENCY MAGNETIC FIELDS GENERATED BY HOUSEHOLD INDUCTION COOKERS FOR EPIDEMIOLOGICAL STUDIES AND DEVELOPMENT OF AN EXPOSURE ESTIMATION MODEL

Kitajima T, Schüz J, Morita A, Ikeda W, Tanaka H, Togawa K, Gabazza EC, Taki M, Toriyabe K, Ikeda T, Sokejima S. Measurement of Intermediate Frequency Magnetic Fields Generated by Household Induction Cookers for Epidemiological Studies and Development of an Exposure Estimation Model. Int J Environ Res Public Health.2022 Sep 21;19(19):11912. doi: 10.3390/ijerph191911912.

Abstract

Introduction: Exposure assessment of intermediate frequency (IF) electromagnetic fields (EMFs) is difficult and epidemiological studies are limited. In the present study, we aimed to estimate the exposure of pregnant women to IF-EMFs generated by induction cookers in the household using a questionnaire and discussed its applicability to epidemiological studies.

Method: Two main home-visit surveys were conducted: a Phase 1 survey to develop an estimation model and a Phase 2 survey to validate the model. The estimation model included the following variables: wattage, cookware diameter, and distance from the hob center (center of the stove). Four models were constructed to determine the importance of each variable and the general applicability for epidemiological studies. In addition, estimated exposure values were calculated based on the Phase 2 survey questionnaire responses and compared with the actual measured values using the Spearman rank correlation coefficient.

Result: The average value of the magnetic field measured in the Phase 1 survey was 0.23 μT (variance: 0.13) at a horizontal distance of 30 cm at the height of the cooking table. The highest validity model was inputted distance from the hob center to the body surface that is variable (correlation coefficient = 0.54, 95% confidence interval: 0.22–0.75). No clear differences were identified in the correlation coefficients for each model (z-value: 0.09– 0.18, p-value: 0.86–0.93).

Discussion and Conclusions: No differences were found in the validity of the four models. This could be due to the biased wattage of the validation population, and for versatility it would be preferable to use three variables (distance, wattage, and estimation using the diameter of the cookware) whenever possible. To our knowledge, this is the first systematic measurement of magnetic fields generated by more than 70 induction cookers in a real household environment. This study will contribute to finding dose–response relationships in epidemiological studies of intermediate-frequency exposure without the use of instrumentation. One of the limitations of this study is it estimates instantaneous exposure in place during cooking only.

Open access paper: https://www.mdpi.com/1660-4601/19/19/11912

EFFECTS OF MEDICALLY GENERATED ELECTROMAGNETIC INTERFERENCE FROM MEDICAL DEVICES ON CARDIAC IMPLANTABLE ELECTRONIC DEVICES: A REVIEW

Barmore W, Patel H, Voong C, Tarallo C, Calkins JB Jr. Effects of medically generated electromagnetic interference from medical devices on cardiac implantable electronic devices: A review. World J Cardiol. 2022 Aug 26;14(8):446-453. doi: 10.4330/wjc.v14.i8.446.

Abstract

As cardiac implantable electronic devices (CIED) become more prevalent, it is important to acknowledge potential electromagnetic interference (EMI) from other sources, such as internal and external electronic devices and procedures and its effect on these devices. EMI from other sources can potentially inhibit pacing and trigger shocks in permanent pacemakers (PPM) and implantable cardioverter defibrillators (ICD), respectively. This review analyzes potential EMI amongst CIED and left ventricular assist device, deep brain stimulators, spinal cord stimulators, transcutaneous electrical nerve stimulators, and throughout an array of procedures, such as endoscopy, bronchoscopy, and procedures involving electrocautery. Although there is evidence to support EMI from internal and external devices and during procedures, there is a lack of large multicenter studies, and, as a result, current management guidelines are based primarily on expert opinion and anecdotal experience. We aim to provide a general overview of PPM/ICD function, review documented EMI effect on these devices, and acknowledge current management of CIED interference

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9453256/

THE EFFECT OF MAGNETIC RESONANCE IMAGING ON MERCURY RELEASE FROM DENTAL AMALGAM AT 3T AND 7T

James R. Allison, Karthik Chary, Chris Ottley, Quoc C. Vuong, Matthew J. German, Justin Durham, Peter Thelwall. The effect of magnetic resonance imaging on mercury release from dental amalgam at 3T and 7T. Journal of Dentistry. 127, 2022, doi: 10.1016/j.jdent.2022.104322.

Abstract

Objectives To measure mercury release from standardised hydroxyapatite/amalgam constructs during MRI scanning and investigate the impact of static field strength and radiofrequency (RF) power on mercury release.

Methods Amalgam was placed into 140 hydroxyapatite disks and matured for 14-days in artificial saliva. The solution was replaced, and samples split into five groups of 28 immediately prior to MRI. One group had no exposure, and the remainder were exposed to either a 3T or 7T MRI scanner, each at high and low RF power. Mercury concentration was measured by inductively coupled plasma mass spectrometry. Groups were compared using one-way ANOVA, and two-way ANOVA for main effects/ interaction of field strength/ RF power.

Results Mercury concentration was increased in the 7T groups (high/ low: 15.43/ 11.33 ng mL−1) and 3T high group (3.59) compared to control (2.44). MRI field strength significantly increased mercury release ($p < .001$) as did RF power ($p = .030$). At 3T, mercury release was 20.3 times lower than during maturation of dental amalgam, and for the average person an

estimated 1.50 ng kg−1 of mercury might be released during one 3T investigation; this is substantially lower than the tolerable weekly intake of 4,000 ng kg−1.

Conclusion Mercury release from amalgam shows a measurable increase following MRI, and the magnitude changes with magnetic field strength and RF power. The amount of mercury released is small compared to release during amalgam maturation. Amalgam mercury release during MRI is unlikely to be clinically meaningful and highly likely to remain below safe levels.
https://www.sciencedirect.com/science/article/pii/S0300571222003773

BIOPHYSICAL MECHANISMS UNDERLYING THE EFFECTS OF STATIC MAGNETIC FIELDS ON BIOLOGICAL SYSTEMS

Zhang B, Yuan X, Lv H, Che J, Wang S, Shang P. Biophysical mechanisms underlying the effects of static magnetic fields on biological systems. Prog Biophys Mol Biol. 2022 Oct 11:S0079-6107(22)00093-1. doi: 10.1016/j.pbiomolbio.2022.09.002.

Abstract

With the widespread use of static magnetic fields (SMFs) in medicine, it is imperative to explore the biological effects of SMFs and the mechanisms underlying their effects on biological systems. The presence of magnetic materials within cells and organisms could affect various biological metabolism and processes, including stress responses, proliferation, and structural alignment. SMFs were generally found to be safe at the organ and organism levels. However. human subjects exposed to strong SMFs have reported side effects. In this review, we combined the magnetic properties of biological samples to illustrate the mechanism of action of SMFs on biological systems from a biophysical point of view. We suggest that the mechanisms of action of SMFs on biological systems mainly include the induction of electric fields and currents, generation of magnetic effects, and influence of electron spins. An electrolyte flowing in a static magnetic field generates an induced current and an electric field. Magnetomechanical effects include orientation effects upon subjecting biological samples to SMFs and movement of biological samples in strong field gradients. SMFs are thought to affect biochemical reaction rates and yields by influencing electron spin. This paper helps people how can harness the favorable biological effects of SMFs.
https://www.sciencedirect.com/science/article/abs/pii/S0079610722000931

THE EUROPEAN UNION PRIORITISES ECONOMICS OVER HEALTH IN THE ROLLOUT OF RADIOFREQUENCY TECHNOLOGIES

Nyberg NR, McCredden JE, Weller SG, Hardell L. The European Union prioritises economics over health in the rollout of radiofrequency technologies. Reviews on Environmental Health. 2022. doi:10.1515/reveh-2022-0106.

Abstract

The fifth generation of radiofrequency communication, 5G, is currently being rolled out worldwide. Since September 2017, the EU 5G Appeal has been sent six times to the EU, requesting a moratorium on the rollout of 5G. This article reviews the 5G Appeal and the EU's subsequent replies, including the extensive cover letter sent to the EU in September 2021, requesting stricter guidelines for exposures to radiofrequency radiation (RFR). The Appeal notes the EU's internal conflict between its approach to a wireless technology-led future, and the need to protect the health and safety of its citizens. It critiques the reliance of the EU on

the current guidelines given by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), that consider only heating and no other health relevant biological effects from RFR. To counteract the ICNIRP position, the 2021 cover letter briefly presented recent research from the EU's own expert groups, from a large collection of European and other international studies, and from previous reviews of the effects of RFR on humans and the environment.

The 5G Appeal asserts that the majority of scientific evidence points to biological effects, many with the potential for harm, occurring below the ICNIRP public limits. Evidence to establish this position is drawn from studies showing changes to neurotransmitters and receptors, damage to cells, proteins, DNA, sperm, the immune system, and human health, including cancer. The 2021 Appeal goes on to warn that 5G signals are likely to additionally alter the behaviour of oxygen and water molecules at the quantum level, unfold proteins, damage skin, and cause harm to insects, birds, frogs, plants and animals. Altogether, this evidence establishes a high priority for the European Union towards (i) replacing the current flawed guidelines with protective thresholds, and (ii) placing a moratorium on 5G deployment so as to (iii) allow industry-independent scientists the time needed to propose new health-protective guidelines. This 2021 Appeal's relevance becomes even more pressing in the context of the EU plans to roll out the sixth generation of wireless technologies, 6G, further adding to the known risks of RFR technology for humans and the environment. This all leads to an important question: Do EU decision makers have the right to ignore EU´s own directives by prioritising economic gain over human and environmental health?

Excerpts

Exposure of captured agencies

The deficits of industry-biased bodies are now beginning to be exposed. In 2021, the US Federal Communications Commission (FCC) was deemed by a US Court of Appeals for the D.C. Circuit ruling as having been negligent for two decades in its role as protector of public health, in that when it decided that its 1996 emission guidelines protected public health, it neglected to consider (**a**) impacts of long term wireless exposure, (**b**)unique impacts to children, (**c**) testimony of people injured by wireless radiation, (**d**) impacts to wildlife and the environment and (**e**) impacts to the developing brain and reproduction [96]. The book Captured Agency describes the compromised position of the FCC in its role as public protector [97]. The compromised actions of ICNIRP since their inception, including inviting industry representatives to the table, are described by Maisch [98, Chapter 4]. As noted by the Turin Court of Appeal [43], opinions from such conflicted advisory bodies as ICNIRP are not reliable.

Safety-first

Alternative guidelines to protect citizens have been created by four groups of industry-independent scientists, based on best available scientific evidence; i.e., setting exposure levels lower than where biological effects with health implications have been found. As described in [101] these four groups recommend the following limits for human exposures to RF-EMR:

1.Building biologists [102] suggest a very low radiation level of no more than 0.1 µW/m2 (in sleeping areas);

2.EuropaEM-EMF Environmental Medicine researchers [103] suggest 1 µW/m2 during the night and 10 µW/m2 during the day time;

3.The BioInitiative-group conclusions (2012 update) [20], made by 29 prominent researchers, and based on 2,200+ scientific reports, suggest 3–6 μW/m2 as the upper limit for exposures;
4.The Council of Europe (CoE) Resolution 1815 [104] Section 8.2.1 says set preventative thresholds for levels of long-term exposure to microwaves in all indoor areas, in accordance with the precautionary principle, not exceeding 0.6 V per metre [1,000 μW/m2], and in the medium term to reduce it to 0.2 V per metre [100 μW/m2].

While there is some variation in the above recommendations, they are all far lower than the ICNIRP 2020 guidelines [14] which, for all frequencies from 2–300 GHz, allow a 30 min average whole body exposure of 10,000,000 μW/m2 (10 W/m2; Table 5, p. 495). For the more recent, higher 5G frequencies of 6–300 GHz, the ICNIRP guidelines allow an average 6 min local exposure over a 4-cm2 region of 200,000,000 μW/m2 (200 W/m2; p. 490). Furthermore, An additional specification of 400 W m −2 has been set for spatial averages of square 1-cm2 regions, for frequencies >30 GHz ([14], p. 490). These ICNIRP specifications mean that future 5G cell phones may send narrow directional beams that impact small regions of body tissue with intensities of 200,000,000–400,000,000 μW/m2. However, the maximum intensity should be no higher than 1–10 μW/m2, according to recommendations 1), 2), 3) above that are aimed at protecting human health.

The above comparisons reveal that ICNIRP and most European states allow incident power densities at least a million times higher than the first three independent advisory bodies mentioned above. This is because the ICNIRP guidelines consider only temperature rises in "tissue simulants" in plastic "heads" but no other risks, like biological effects on living glial cells, blood or DNA, which have been well documented in EU's sponsored research and reviews [1, 3, 4, 6, 7].

Concluding remarks

At the current juncture, millions of EU citizens are relying on the EU to address the issues raised in the EU 5G Appeal. The EU decision makers need to put aside their industry-fuelled fantasies of a digital saviour for mankind and instead, ensure that industry acts according to EU laws, made to prioritise humans and planetary health above industry profit or science fiction futures. Any economic benefits from 5G are likely to be outweighed by the risk of harm to the health of billions of people around the world [33].

If the EU continues to fail to act on these warnings, Europe may end up being faced with a non-reversible burgeoning health impact on humans, especially children and the environment.

To allow the levels and frequencies of exposures to continue unfettered is to put the world population and the environment at great risk, especially young people [28].

Open access paper: https://www.degruyter.com/document/doi/10.1515/reveh-2022-0106/html

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SOME THOUGHTS ON THE POSSIBLE HEALTH EFFECTS OF ELECTRIC AND MAGNETIC FIELDS AND EXPOSURE GUIDELINES

Barnes F, Freeman Jr ER. Some thoughts on the possible health effects of electric and magnetic fields and exposure guidelines. Frontiers in Public Health. Vol. 10. 2022. doi: 10.3389/fpubh.2022.994758.

Abstract

Concerns about the possible health effects from exposure to weak electric and magnetic (EM) fields have been debated since the early 1960s. It is now well established that biological systems respond to exposure to weak EM fields at energy levels well below the current safety guidelines which result in modification of their functionality without significant changes in temperature. These observations are adding to the debate over what should be done to protect the users of cellular telecommunications systems. Experimental results showing both increases and decreases in cancer cell growth rates and concentration of reactive oxygen species for exposure to nano-Tesla magnetic fields at both radio frequencies (RF) and extra low frequencies (ELF) are cited in this paper. Some theoretical models on how variations in EM exposure can lead to different biological outcomes and how feedback and repair processes often mitigate potential health effects due to long-term exposure to low-level EM energy sources are presented. Of particular interest are the application of the radical pair mechanisms that affect polarization of electrons, and nuclear spins and the importance of time-delayed feedback loops and the timing of perturbations to oscillations in biological systems. These models help account for some of the apparently conflicting experimental results reported and suggest further investigation. These observations are discussed with particular emphasis on setting future safety guidelines for exposure to electromagnetic fields in cellular telecommunications systems. The papers cited are a very small fraction of those in the literature showing both biological effects and no effects from weak electric and magnetic fields.

Excerpts

The central problems to be solved include:

1) Determining the exposure amplitude, polarization and duration of electromagnetic fields at specific positions of interest in the body as a function of the exposing fields as a function of time.
2) Determining causal relationships between long duration exposure to low-level EM fields and the various biological responses reported in current research.
3) Quantifying the interactions between EM fields and biology with measurements that are not only accurate but repeatable. Some of the low energy EM effects on micro-biological systems are well documented in laboratory experiments but are difficult to translate to macro-biological system responses.
4) Sorting out which aspects of biological systems are directly driven by RF fields vs. the myriad of other independent variables at work.
5) Understanding how the repair mechanisms in biological systems alter biological processes in the presence of low-level EM fields.

Several issues confront regulators:

1) Should regulations be set that "protect" all the population all the time, including those with other health conditions that make them more susceptible to EM exposure, or should regulations only protect most of the population most of the time. The degree of control has huge implications on cost and efficacy.
2) Simplifying the explanations of the physical mechanisms involved such that there is general acceptance of the need for regulation is a non-trivial part of the regulatory process. Scientists, producers, operators, and users have differing imperatives that need to be considered. Such situations invite a lot of political hubris and conflict.
3) How regulators quantify and then rationalize the tradeoffs between the economic and social benefits of cellular technology vs. potentially damaging health effects of long-term exposure to low levels of EM energy is important in determining the regulations that are proposed.

Four strategies for reducing RF exposure might include:

1) Designing the transmitter in user devices to reduce the instantaneous RF power levels emitted is the most direct way to reduce RF exposure but this has serious system performance implications and high implementation costs. Manufacturers already try to minimize the instantaneous RF power output of cell phones to maximize battery life. Further reductions in RF power output will significantly impact signal to noise ratio and reduce the maximum range of any given phone within a cell phone tower matrix. This will have a significant impact on system infrastructure (number of cell phone towers needed to provide coverage) and operating cost. Another technique for reducing instantaneous power output absorbed by users is to use narrow beam directional antennas in user devices that focuses the output power on the closest cell tower receiver. This approach is being incorporated into 5G systems. Size and weight considerations are a major constraint in mobile devices.
2) Reducing the density of RF power (Watts/M2) being absorbed by the body of a user can also be accomplished by increasing the distance between the transmitting antenna and the user's body and head. Power density falls off very rapidly with increasing distance from the transmitting antenna typically as 1/Rn reduction where n is a number usually >1. It is to be noted that increasing use of data and moving a smart phone away from the body reduces the power levels incident on the head.
3) Research data indicates biological effects of RF signals are frequency dependent. Redesigning transmitters to eliminate frequencies that are proven to produce biological effects could be employed, but this could have a significant impact on system capacity since each frequency band carries a lot of data in today's system.
4) The last, and least expensive approach is to limit cumulative user exposure to RF energy in a given period of time by shutting the phone "Off". Establishing limits for the maximum accumulated duration of an individual's exposure would require extensive clinical testing on large populations of users. Once those numbers were set, there would be very little cost impact on the operators or the users to implement. Major issues would be lack of access in emergency situations and gaining user acceptance on such limitations and the self-discipline to avoid over exposure. To help with that applications software could be installed on the phone that calculates the accumulated exposure and then reports the data on the phone's visual readout.

Conclusion

The data above and many more papers not cited indicate that biological systems can sense and respond to very weak electric and magnetic field by changing biological parameters such as reactive oxygen species concentrations at the cellular level which affect health and wellbeing of living organisms. High concentrations of reactive oxygen species for extended periods of time are known to be associated with adverse health effects (19). There are also many cases where no damaging effects have been observed. It is presumed that the body's feedback and repair systems keep the concentrations of these molecules within the normal operating ranges and the cumulative effects of RF energy are negligible. We hypothesize that EM effects vary from person to person and are a function of exposure conditions in conjunction with other stresses that affect concentrations of these molecules. Note this degree of variability explains why many papers do not show EM effects while some of the experiments on hypersensitive people show effects. We have chosen not to go into discussion of hypersensitive people as it would take more space than we wish to devote to it in this paper.

It is clear that more research needs to be done to enable definition of standards for RF exposure that are reasonable and allow a simple, low-cost communications system to function safely. Although both industry and government have funded significant amounts of expensive research, relatively few studies have used radical pair theory and other quantum mechanical models to guide their experiments or track the chemical changes induced by exposures to weak electromagnetic fields. Additionally, they have not delt with long term effects of exposure to low-level exposure that take into account biological feedback and repair systems, that may not be able to handle the effects of compounding stresses and the fact that humans have different responses at different time.

Forcing a solution that eliminates all wireless communications is not a reasonable approach. Allowing the telecommunications industry and users to ignore the potential harm indicated by some of the experiments showing the effects of weak field exposures is equally unsatisfactory given the data that are currently available. Imposing operating standards without understanding the root causes in science, and social impacts and costs is tempting, but also potentially dangerous and can potentially lead to health problems for a large fraction of the population.

In the US, most industries can be held liable for not pursuing research on the safety of their products. With such a large number of users, it is incumbent on system designers, operators, managers, and regulators to invest the time and energy to understand the risks of long-term exposure to low-level EM fields to determine potential health hazards. In the short term, implementing ways to reduce exposure voluntarily is likely to be the cheapest solution, but human behavior is often unpredictable and unreliable. Ultimately more research will better define the conditions where EM exposures can lead to changes in the biological system that are not compensated by biological control systems and repair mechanisms.

Open access paper: https://www.frontiersin.org/articles/10.3389/fpubh.2022.994758/full

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ASSOCIATION BETWEEN ELECTRONIC DEVICE USAGE AND SPERM QUALITY PARAMETERS IN HEALTHY MEN SCREENED AS POTENTIAL SPERM DONORS

Chen HG, Wu P, Sun B, Chen JX, Xiong CL, Meng TQ, Huang XY, Su QL, Zhou H, Wang YX, Ye W, Pan A. Environ Pollut. 2022 Sep 1;312:120089. doi: 10.1016/j.envpol.2022.120089.

Highlights

- Semen samples were repeatedly collected from 1454 healthy men.
- Electronic device use was evaluated by comprehensive questionnaire.
- Electronic device use was related to lower semen quality in modest effect size.
- Daily calling time was associated with lower sperm concentration and total count.

Abstract

Cell phone use and radio-frequency electromagnetic radiation (RF-EMF) are rapidly increasing and may be associated with lower semen quality, yet results from epidemiological studies are inconclusive. Information on electronic devices use was collected through standard questionnaires from 1454 men aged 22-45 years old.

Semen volume, sperm concentration, total sperm count, total motility, progressive motility, and normal morphology in repeated specimens were determined by trained clinical technicians. Percent changes [95% confidence intervals (CIs)] were estimated as (10β-1) × 100 for electronic devices use associated with repeated sperm quality parameters in the linear mixed-effect models. After adjusting for multiple confounders, we found significant inverse associations of total duration of electronic devices use with sperm progressive motility and total motility, duration of cell phone and computer use with sperm concentration, progressive motility, and total motility (all $P < 0.05$). No significant association was found between cell phone/computer use alone and sperm quality parameters. Moreover, per hour increase of time spent on cell phone talking was associated with decreased sperm concentration and total count by an average of -8.0% (95% CI: -15.2%, -0.2%) and -12.7% (95% CI: -21.3%, -3.1%), respectively. Besides, daily calling time was associated with lower sperm progressive motility and total motility among those who used headsets during a call (P for interaction <0.05). In conclusion, our study suggested that more time spent on electronic devices use had a modest reduction effect on semen quality. Daily calling time was significantly associated with lower sperm concentration and total count, and using headsets during a call appeared to aggravate the negative association between daily calling time and sperm motility. Additional studies are needed to confirm these findings - https://pubmed.ncbi.nlm.nih.gov/36058315/

Conclusions

In conclusion, more time spent on electronic devices use was associated with decreased semen quality in modest effect size. Daily calling time was significantly associated with lower sperm concentration and total count, and it might interact synergistically with headset use during a call to further decrease sperm progressive motility and total motility. Although our research suggests that electronic devices exert no obvious reproductive hazards to healthy men with good fertility, we still advise men with a pregnancy plan to avoid excessive electronic devices use, especially avoid using headsets during a call. Additional well-designed prospective population studies are required to identify the effects of electronic devices use on semen quality more precisely, and to evaluate the clinical importance of the risk to both sub-fertile men and the general population.

HOW MUCH EXPOSURE FROM 5G TOWERS IS RADIATED OVER CHILDREN, TEENAGERS, SCHOOLS AND HOSPITALS?

L. Chiaraviglio et al.,IEEE Open Journal of the Communications Society, 2022, doi: 10.1109/OJCOMS.2022.3208938.

Abstract

The rolling-out of 5G antennas over the territory is a fundamental step to provide 5G connectivity. However, little efforts have been done so far on the exposure assessment from 5G cellular towers over young people and "sensitive" buildings, like schools and medical centers. To face such issues, we provide a sound methodology for the numerical evaluation of 5G (and pre-5G) downlink exposure over children, teenagers, schools and medical centers. We then apply the proposed methodology over two real scenarios. Results reveal that the exposure from 5G cellular towers will increase in the forthcoming years, in parallel with the growth of the 5G adoption levels. However, the exposure levels are well below the maximum ones defined by international regulations.

Moreover, the exposure over children and teenagers is similar to the one of the whole population, while the exposure over schools and medical centers can be lower than the one of the whole set of buildings. Finally, the exposure from 5G is strongly lower than the pre-5G one when the building attenuation is introduced and a maturity adoption level for 5G is assumed.

Summary

We have assessed the impact of 5G towers on the EMF exposure over children/teenagers, school buildings and medical buildings. After introducing a novel methodology for the analysis of exposure over population and buildings, we have applied it in two meaningful scenarios that are subject to different urbanization levels as well as tower deployments. Our results reveal that, although 5G exposure radiated by towers is initially lower than the pre-5G one, 5G will become the dominant source of exposure from cellular towers when a maturity level will be reached. However, the scaling factors applied to the maximum power radiated by mid-band/mm-Wave antennas, the tower distribution and the positioning of the buildings are important aspects heavily influencing the exposure levels over young people and "sensitive" places. Eventually, the actual level of exposure over children and teenagers is largely impacted by the building attenuation level, which has a stronger effect over mid-band and mm-Wave 5G frequencies compared to pre-5G ones. Overall, our results indicate that the total exposure levels are always lower than the EMF limits reported in international regulations. Moreover, children and teenagers receive similar amount of exposure compared to the whole population. Eventually, the positioning of the "sensitive" building has an impact on the exposure level, but, however, the observed exposure trends are similar compared to the ones of the whole set of buildings.

As future work, we plan to extend our assessment to entire municipalities/cities, including zones covered by 5G small cells. In addition, as propagation has a strong effect over the exposure received by children and teenagers, massive campaigns of EMF measurements from 5G towers should be performed, especially inside the buildings. Finally, the investigation of joint uplink and downlink 5G exposure is another avenue of research. https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9900418

SIX MONTHS IN THE LIFE OF A CELLULAR TOWER: IS 5G EXPOSURE HIGHER THAN PRE-5G ONE?

L. Chiaraviglio, C. Lodovisi, D. Franci, S. Pavoncello, T. Aureli. Six Months in the Life of a Cellular Tower: Is 5G Exposure Higher than pre-5G One? 2022 IEEE International Symposium on Measurements & Networking (M&N), 2022, pp. 1-6, doi: 10.1109/MN55117.2022.9887670.

Abstract

5G service is already available in many countries, including Italy. Currently, 5G networks are run in parallel to the already deployed pre-5G ones (including 4G). In this work, we face the problem of continuously monitoring the exposure from a vantage point over a very long period of time (i.e., several months). After designing and validating a measurement setup suitable for our aims, we extensively collected 5G and pre-5G exposure data from the considered location. Results show that, although the share of 5G exposure is in general lower than pre- 5G one, both intensity and occurrence of 5G exposure peaks are rapidly increasing over the months, suggesting a growth of 5G exposure levels in the near future.

https://ieeexploreieeeorg.libproxy.berkeley.edu/stamp/stamp.jsp?tp=&arnumber=9887670&isnumber=9887532

MEASUREMENT OF PERSONAL RADIO FREQUENCY EXPOSURE IN JAPAN: THE HOKKAIDO STUDY ON THE ENVIRONMENT AND CHILDREN'S HEALTH

Yamazaki K, Ikeda-Araki A, Miyashita C, Tamura N, Yoshikawa T, Hikage T, Omiya M, Mizuta M, Ikuyo M, Tobita K, Onishi T, Taki M, Watanabe S, Kishi R. Measurement of personal radio frequency exposure in Japan: The Hokkaido Study on the Environment and Children's health. Environ Res. 2022 Sep 26:114429. doi: 10.1016/j.envres.2022.114429.

Abstract

The opportunities for exposure to radiofrequency electromagnetic fields (RF-EMF) among children are increasing. Children's exposure to RF-EMF in Japan was recorded using a personal exposure meter (ExpoM-RF), and factors associated with the exposure examined. A total of 101 children, aged 10-15 years old, participated in the prospective birth cohort "Hokkaido study". RF-EMF data were recorded in the 700 MHz-5.8 GHz frequency range for 3 days. The recorded data were summarized into six groups of frequency bands: downlink from mobile phone base stations (DL), uplink from mobile phones to a base station (UL), Wireless Local Area Network (LAN), terrestrial digital TV broadcasting (digital TV), 2.5 GHz and 3.5 GHz Time Division Duplex (TDD), 1.9 GHz TDD, and total (the summation of power density in all measured frequency bands). A questionnaire was used to document the internet environment (at home) and mobile phone usage. Personal RF-EMF exposure in Japanese children was lower than that reported in studies in Europe. The DL signals from mobile phone base stations were the most significant contributors to total exposure, while Wireless LAN and digital TV were only higher at home. The urban residence was consistently associated with increases in the four groups of frequency bands (DL, UL, digital TV, and TDD). TDD level has several associations with mobile phone usage (calls using mobile phones, video viewing, text message service, and online game). The association between inattention/hyperactivity subscale of the Strengths and Difficulties Questionnaire (SDQ) and higher Wireless LAN exposure at nighttime was also noted. Further studies with additional data will shed light on factors involved in RF-EMF exposure among Japanese children.

Excerpts

Regarding microenvironments, RF exposure from outdoor environmental sources was higher when outdoors than indoors, similar to findings of other studies (Birks et al., 2018; Gallastegi et al., 2018; Joseph et al., 2010; Verloock et al., 2014). The exposure levels for DL, digital TV from outdoor environmental sources (e.g. base station) were higher outside, and that in Wireless LAN was higher in the home. Regarding the contribution of each band to the total exposure level, the exposure to the DL contributed the most to the total exposure in all microenvironments....

... Interestingly, Wireless LAN levels at nighttime were significantly higher among those with high hyperactivity/inattention scores of SDQ, one of the common symptoms of ADHD, than those with low scores. Although the association between ADHD symptoms and internet addiction has been reported (Ho et al., 2014; Wang et al., 2017; Yen et al., 2009), there was no relationship between internet addiction and RF-EMF exposure in the present study. Tateno et al. (2016) suggested that ADHD traits, such as impulsivity, could be related to difficulty in controlling internet use and online gaming. Therefore, the exposure to Wireless LAN recorded by the exposure meter might increase for those who could not limit the use of wireless electrical devices (mobile phones, gaming devices, among others) at nighttime because of impulsivity, rather than internet addiction....

Conclusions

We recorded children's personal RF-EMF exposures using the exposure meter and examined related factors for their exposure. The personal RF-EMF exposure in Japanese children was lower than that reported in previous European studies. Downlink from mobile phone base stations was the most significant contributor to the total exposure, while Wireless LAN and digital TV were higher at home than in other microenvironments. There were several significant associations between internet environment and mobile phone usage and exposure level in the daytime analysis. Among them, the urban residence and related characteristics were consistently associated with higher levels of DL, UL, digital TV, and TDD band. At nighttime, the association between the inattention/hyperactivity subscale of SDQ and Wireless LAN exposure was found in addition to associations between the internet environment or mobile phone usage and the RF-EMF exposure. Further studies with additional data and robust study designs are required to explore the most possible factors involved in RF-EMF exposure among Japanese children.

https://pubmed.ncbi.nlm.nih.gov/36174753/

ASSOCIATION OF INCREASED PAIN INTENSITY, DAYTIME SLEEPINESS, POOR SLEEP QUALITY, & QUALITY OF LIFE WITH MOBILE PHONE OVERUSE IN PATIENTS WITH MIGRAINE

Butt M, Chavarria Y, Ninmol J, Arif A, Tebha SS, Daniyal M, Siddiqui UM, Shams SS, Sarfaraz Q, Haider SF, Essar MY. Brain Behav. 2022 Sep 20:e2760. doi: 10.1002/brb3.2760.

Abstract

Background: The number of regular smartphone users has increased dramatically worldwide. Headaches, followed by sleep difficulties, forgetfulness, dizziness, and other ailments, are among the most prevalent complaints among smartphone users during or after use. In addition, migraine is a debilitating disease and is the world's second leading cause of

disability. Hence, we performed this study to determine how smartphone overuse influenced migraine patients' level of disability, pain intensity, sleep quality, and overall quality of life.

Methods: In this observational study, the patients were divided into two groups high mobile phone use group (HMPUG) and the low mobile phone user group (LMPUG) using the Mobile Phone Problematic Use Scale. We assessed, for each group, patients' level of disability, pain intensity, sleep quality, daytime sleepiness, and quality of life through the Migraine Disability Assessment Scale, Visual Analogue Scale, Pittsburgh Sleep Quality Index, Epworth Sleepiness Scale, and 24-h Migraine Quality of Life Questionnaire, respectively.

Results: Our study showed that the respondents' average age was 27.59 (9.79) years. The average number of family members was 5.98 (2.3251). A total of 65.8% (n = 263) of the 400 participants were female, while 34.3 % (n = 137) were male. Greater pain intensity, poor sleep quality, and reduced medication effectivity were found in HMPUG compared to LMPUG ($p < .05$). However, increased duration of migraine and medication intake was reported in the LMPUG ($p < .05$).

Conclusion: We observed that smartphone overuse could worsen pain, sleep, and reduce treatment efficacy in individuals with migraine. Therefore, controlled smartphone use is recommended to avoid worsening symptoms.
https://onlinelibrary.wiley.com/doi/full/10.1002/brb3.2760

A QUALITATIVE APPROACH TO EXPERIENTIAL KNOWLEDGE IDENTIFIED IN FOCUS GROUPS AIMED AT CO-DESIGNING A PROVOCATION TEST IN THE STUDY OF ELECTROHYPERSENSITIVITY

Bordarie J, Dieudonné M, Ledent M, Prignot N. Ann Med. 2022 Dec;54(1):2363-2375. doi: 10.1080/07853890.2022.2114605.

Abstract

Patients' experiential knowledge is increasingly recognised as valuable for biomedical research. Its contribution can reveal unexplored aspects of their illnesses and allows research priorities to be refined according to theirs. It can also be argued that patients' experiential knowledge can contribute to biomedical research, by extending it to the most organic aspects of diseases. A few examples of collaboration between medicine and patient associations are promising, even if there is no single, simple methodology to apply. This article provides feedback on a project involving the experiential knowledge of electrohypersensitive persons with a view to developing an experimental protocol to study their condition. It presents the participatory approach with focus groups that was implemented and reflects on ways to take advantage of experiential knowledge. It also demonstrates the complexity of the electrohypersensitivity syndrome and reflects on the difficult transition between the experiential knowledge and the experimental design of provocation studies.

KEY MESSAGES

Experiential knowledge is a valuable source of information for research and the design of investigation protocols.The participatory approach allows co-designing protocols by drawing on experiential knowledge.The controversial dimension of EHS reveals the complexity of translating experiential knowledge into an experimental protocol.
https://www.tandfonline.com/doi/full/10.1080/07853890.2022.2114605

DISEASE BURDEN, RISK FACTORS, AND TRENDS OF PRIMARY CENTRAL NERVOUS SYSTEM (CNS) CANCER: A GLOBAL STUDY OF REGISTRIES DATA

Huang J, Chan SC, Lok V, Zhang L, Lin X, Lucero-Prisno DE, Xu W, Zheng ZJ, Elcarte E, Withers M, Wong MCS; NCD Global Health Research Group, Association of Pacific Rim Universities (APRU). Neuro Oncol. 2022 Sep 1:noac213. doi: 10.1093/neuonc/noac213.

Abstract

Background: This study aimed to evaluate the global incidence, mortality, associated risk factors, and temporal trends of central nervous system (CNS) cancer by sex, age, and country.

Methods: We extracted incidence and mortality of CNS cancer from the GLOBOCAN (2020), Cancer Incidence in Five Continents series I-X, WHO mortality database, the Nordic Cancer Registries, and the Surveillance, Epidemiology, and End Results Program. We searched the Global Health data exchanges for the prevalence of its associated risk factors. We tested the trends by Average Annual Percentage Change (AAPC) from Joinpoint regression analysis with 95% confidence intervals in different age groups.

Results: The age-standardized rates (ASRs) of CNS cancer incidence and mortality were 3.5 and 2.8 per 100,000 globally. Southern Europe (ASR=6.0) and Western Asia (ASR=4.2) had the highest incidence and mortality, respectively. The incidence was associated with Human Development Index, Gross Domestics Products per capita, prevalence of traumatic brain injuries, occupational carcinogens exposure, and mobile phone use at the country level. There was an overall stable and mixed trend in the CNS cancer burden. However, increasing incidence was observed in younger male population from five countries, with Slovakia (AAPC=5.40; 95% CI=1.88, 9.04; p=0.007) reporting the largest increase.

Conclusions: While the overall global trends of cancer have been largely stable, significant increasing trends were found in the younger male population. The presence of some higher-HDI countries with increasing mortality suggested an ample scope for further research and exploration of the reasons behind these epidemiological trends. https://pubmed.ncbi.nlm.nih.gov/36048182/

Key points

Brain cancer burden was higher in more developed countries and male population. Brain cancer was related to HDI, GDP, brain injuries, carcinogens, and phone use. There was an increasing trend of brain cancer in the younger male population.

ROAD USER EXPOSURE FROM ITS-5.9 GHZ VEHICULAR CONNECTIVITY

Benini M, Parazzini M, Bonato M, Gallucci S, Chiaramello E, Fiocchi S, Tognola G. Road User Exposure from ITS-5.9 GHz Vehicular Connectivity. Sensors (Basel). 2022 Sep 15;22(18):6986. doi: 10.3390/s22186986.

Abstract

This study addressed an important but not yet thoroughly investigated topic regarding human exposure to radio-frequency electromagnetic fields (RF-EMF) generated by vehicular connectivity. In particular, the study assessed, by means of computational dosimetry, the RF-

EMF exposure in road users near a car equipped with vehicle-to-vehicle (V2V) communication antennas. The exposure scenario consisted of a 3D numerical model of a car with two V2V antennas, each fed with 1 W, operating at 5.9 GHz and an adult human model to simulate the road user near the car. The RF-EMF dose absorbed by the human model was calculated as the specific absorption rate (SAR), that is, the RF-EMF power absorbed per unit of mass. The highest SAR was observed in the skin of the head (34.7 mW/kg) and in the eyes (15 mW/kg); the SAR at the torso (including the genitals) and limbs was negligible or much lower than in the head and eyes. The SAR over the whole body was 0.19 mW/kg. The SAR was always well below the limits of human exposure in the 100 kHz-6 GHz band established by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). The proposed approach can be generalized to assess RF-EMF exposure in different conditions by varying the montage/number of V2V antennas and considering human models of different ages.
Open access paper: https://www.mdpi.com/1424-8220/22/18/6986

STUDY OF MICROWAVE NON-THERMAL EFFECTS ON HYDROGEN BONDING IN WATER BY RAMAN SPECTROSCOPY

Han G, Liu F, Zhang T, Xu W, Zhang Y, Wu N, Ouyang S. Study of microwave non-thermal effects on hydrogen bonding in water by Raman spectroscopy. Spectrochim Acta A Mol Biomol Spectrosc. 2022 Sep 22;285:121877. doi: 10.1016/j.saa.2022.121877.

Abstract

Microwave chemistry plays an important role in organic synthesis. It has been debatable whether or not there are microwave non-thermal effects. Through analyzing the Raman spectra of pure water under two different heating methods (oil bath and microwave), the existence of microwave non-thermal effect is verified in this paper. The findings demonstrate that temperature has a significant impact on the Raman shift of the OH stretching band, which shifts to a high wave number as temperature rises and deforms the hydrogen bond (HB) network structure. Because microwave electric fields selectively heat water molecules (polar molecules) and destroy hydrogen bond structures in water, results in microwave heating more severe destruction of fully hydrogen-bonded structure than oil bath and transforms it more quickly into the partially hydrogen-bonded and free H2O structure. Under the non-thermal effects of microwaves, hydrogen bonds that initially existed as stable tetrahedral structures are transformed into chain-like structures more rapidly. By comparing the Raman shift, it can be found that the microwave non-thermal effect can affect the hydrogen bonding in water for a long time (>1h). This study provides an experimental basis for enriching the mechanism of microwave non-thermal effects on hydrogen bonding.
https://pubmed.ncbi.nlm.nih.gov/36174402/

MOLECULAR DYNAMICS RESEARCH OF SPATIAL ORIENTATION AND KINETIC ENERGY OF ACTIVE SITE COLLISION OF CARNOSINE UNDER WEAK MICROWAVE IRRADIATION

Gou D, Huang K, Liu Y, Shi H, Wu Z. Molecular Dynamics Research of Spatial Orientation and Kinetic Energy of Active Site Collision of Carnosine under Weak Microwave Irradiation. J Phys Chem B. 2022 Sep 22. doi: 10.1021/acs.jpcb.2c03930.

Abstract

The molecular mechanism of the microwave nonthermal effect is still not clear. This work investigated the spatial orientation and kinetic energy of active site collision of carnosine, a natural bioactive dipeptide, under the weak microwave irradiation using the molecular dynamics simulation. Our results showed the influences of the temperature, microwave intensity, microwave frequency, and microwave polarization mode (linear polarization and circular polarization) on the spatial orientation and kinetic energy of active site collision of carnosine. First, under the constant intensity and frequency of linear polarization microwave irradiation, the increment of the collision probability between the 6N atom of carnosine and the 28H atom of the other carnosine at effective space angle decreases from 85.0% to 3.5% with increasing temperature. Second, with the increase of microwave intensity, the change of spatial orientation and kinetic energy becomes more and more significant. However, the change of circular polarization microwaves on the spatial orientation and kinetic energy of collision is weaker than that of linear polarization. Third, under the constant intensity of linear polarization microwave irradiation, the collision probability between the 6N atom and the 28H atom at effective space angle decreases from 70.2% to 14.7% with increasing frequency. Finally, under the microwave polarization, the spatial orientation and kinetic energy of molecular collision are changed, which is summarized as the microwave postpolarization effect (MWPPE). The dependence of MWPPE on temperature, microwave intensity, microwave frequency, and polarization mode is very complicated. In the end, this effect can provide a new insight into the molecular mechanism of the microwave nonthermal effect.
https://pubmed.ncbi.nlm.nih.gov/36134752/

Conclusions

The goal of this investigation is to study the spatial orientation and kinetic energy of active site collision of carnosine under weak microwave irradiation. In this work, the effects of temperature, microwave intensity, microwave frequency, and microwave polarization mode (linear polarization and circular polarization) on carnosine active site collision were investigated using molecular dynamics simulation. For the active site collision of carnosine, we mainly targeted the collision between the 6N atom of carnosine and the 28H atom of the other carnosine and the collision between the 6N atom of carnosine and the 30H atom of the other carnosine. The influence of weak microwave irradiation on active site collision of carnosine is affected by many factors mentioned above.

First, for linear polarization microwave radiation with the constant microwave intensity and frequency, the increment of total collision number decreases with the increase of temperature. Similarly, the increment of collision probability at specific spatial angle also decreases, and the fraction of high-energy collisions also decreases. This confirms that the molecular thermal motion becomes more intense as the temperature rises, which weakens the polarization effect of microwaves. Second, with the increase of microwave intensity, the influence of spatial orientation and kinetic energy becomes more and more significant.

However, the effect of circular polarization on the spatial direction and kinetic energy of collision is weaker than that of linear polarization. This shows that, compared with linear polarization microwaves, the direction of the electric field in circular polarization changes faster, and the orientation effect of dipole molecules is obviously weaker than that of linear polarization. Third, under the constant intensity of linear polarization microwave radiation, with the increase of microwave frequency, the influence of spatial direction and kinetic energy becomes weaker and weaker. This proves that the orientation effect of molecules following the direction of electric field decreases with increasing microwave frequency. Finally, we determine the effect of the microwave radiation on the spatial orientation and kinetic energy of collision. The higher intensity is the more obvious the effect will be. However, the higher temperature, the higher frequency, and circular polarization will weaken the effect.

On the basis of the collision theory, we further verify the total effect of weak microwave irradiation on spatial orientation and kinetic energy of active site collision by analyzing the effective molecular collision number and introduce electromagnetic action factor. The conclusion is consistent with that described above. At last, the effect of the weak microwaves on the spatial orientation and kinetic energy of active site collision is called the microwave postpolarization effect (MWPPE). The MWPPE provides a new way to understand the molecular mechanism of the microwave nonthermal effect. In addition, it can also provide useful reference for designing experiments to verify the nonthermal effect of weak microwave irradiation.

HUMAN EXPOSURE INFLUENCE ANALYSIS FOR WIRELESS ELECTRIC VEHICLE BATTERY CHARGING

El-Shahat A, Danjuma J, Abdelaziz AY, Abdel Aleem SHE. Human Exposure Influence Analysis for Wireless Electric Vehicle Battery Charging. Clean Technologies. 2022; 4(3):785-805. https://doi.org/10.3390/cleantechnol4030048

Abstract

Wireless charging schemes aim to counter some drawbacks of electric vehicles' wired charging, such as the fact that it does not encourage mobility, leads to safety issues regarding high voltage cables, power adapters high cost, and has more battery waste by companies. In this paper, a comparative study of wireless power transfer multiple coil geometries is performed to analyze the efficiency, coupling coefficient, mutual inductance, and magnetic flux density production for each geometry. Results show that coil geometry, current excitation, and shielding techniques within the Wireless Electric Vehicle Charging (WEVC) system substantially influence magnetic flux leakage. In addition, the paper proposes an analytical framework for a WEVC scheme via electromagnetic resonance coupling. Safety considerations of the WEVC system, including the effects on humans, are investigated in several scenarios based on the relative location of the human while EV charging is conducted as the leading paper's goal. The exposure measurements are performed across various radial distances from the coils using 3-D FEA ANSYS Maxwell Software (American technology company, Pennsylvania, United States). The analysis shows that WEVC systems can achieve high power transfer, resulting in increased magnetic flux leakage around the coils. The safe distance for humans and animals during the charging sequence is attained from research results. For instance, in the 120 mm spiral coil, 120 mm square coil, and 600 mm spiral coil

operating at 1 A, excitation, the SAR levels are under the threshold of 700 mm away from the coils. For the 600 mm spiral coil excited at 8 A, the SAR levels fall under the threshold at 900 mm away from the coils. When shielding is utilized, the safe distance is improved by up to 350 mm. Considering the regulations of the Non- Ionizing Radiation Protection (ICNIRP) standards, 600 mm is a safe distance away from the coils, and, vertically, anywhere past 300 mm is safe for humans.

Open access paper: https://www.mdpi.com/2571-8797/4/3/48

PHYSICAL DIFFERENCES BETWEEN MAN-MADE & COSMIC MICROWAVE ELECTROMAGNETIC RADIATION & EXPOSURE LIMITS, & RADIOFREQUENCIES AS GENERATORS OF BIOTOXIC FREE RADICALS

Georgiou CD, Kalaitzopoulou E, Skipitari M, Papadea P, Varemmenou A, Gavriil V, Sarantopoulou E, Kollia Z, Cefalas A-C. Physical Differences between Man-Made and Cosmic Microwave Electromagnetic Radiation and Their Exposure Limits, and Radiofrequencies as Generators of Biotoxic Free Radicals. Radiation. 2022; 2(4):285- 302. doi: 10.3390/radiation2040022.

Simple Summary

There is an inconsistency between the position that radio frequencies are sources of minor thermal effects in cells, tissues and living organisms and the experimental evidence indicating that non-ionising radiation is harmful, even at shallow power density radiation levels. A quantum mechanical survey of the interaction between microwaves and matter points to free radical-associated cytotoxic alterations of biomatter upon microwave irradiation.

Abstract

The critical arguments for radiofrequency radiation exposure limits are currently based on the principle that radio frequencies (RF) and electromagnetic fields (EMFs) are non-ionising, and their exposure limits are even 100-fold lower than those emitted from the Sun in the whole RF-EMF spectrum. Nonetheless, this argument has been challenged by numerous experimental and theoretical studies on the diverse biological effects of RF-EMF at much lower power density (W/m2) levels than today's exposing limits. On the other hand, less attention has been given to counterarguments based on the differences in the physics concepts underlying man-made versus natural electromagnetic radiation (EMR) and on the fact that man's biology has been adapted to the natural EMR levels reaching Earth's surface at single EMF wavelengths, which are the natural limits of man's exposure to EMFs. The article highlights the main points of interaction of natural and man-made radiation with biomatter and reveals the physical theoretical background that explains the effects of man-made microwave radiation on biological matter. Moreover, the article extends its analysis on experimental quantum effects, establishing the "ionising-like" effects of man-made microwave radiation on biological matter.

Excerpt

The current man-made power density exposure limits are compared to nature's limits, and some observed biological effects are shown in Figure 3. The biological effects are based on studies presented in the BioInitiative 2012 Report [34,80–139], which have been updated in the present study. Nonetheless, the number of such studies has grown since then, listing as indicative ones that focus on oxidative stress [2,44,53,54,106,128,140,141], DNA damage

[54,142] and carcinogenesis [143–147]. Indeed, the lowest power density of 1 × 10−9 W/m2 (1 × 10−6 mW/m2) with observed biological effects (oxidative damage, reactive oxygen species generation, DNA damage/repair failure) is ~10 13-fold higher than a natural exposure limit of ~1 × 10−22 W/m2 (10−19 mW/m2) of exposure to the cosmic frequencies and 10 10-fold lower than the today's power density exposure limit of 10 W/m2 (1 × 10 4 mW/m2). Even the 3 to 6 × 10−6 W/m2 (3 to 6 × 10−3 mW/m2) limit proposed by the BioInitiative 2012 Report [148] is 10 14− to 10 18−fold higher than the natural exposure limit.
Open access paper: https://www.mdpi.com/2673-592X/2/4/22

INVESTIGATION OF OXIDATIVE DAMAGE, ANTIOXIDANT BALANCE, DNA REPAIR GENES, AND APOPTOSIS DUE TO RADIOFREQUENCY-INDUCED ADAPTIVE RESPONSE IN MICE

Kucukbagriacik Y, Dastouri M, Ozgur-Buyukatalay E, Akarca Dizakar O, Yegin K. Investigation of oxidative damage, antioxidant balance, DNA repair genes, and apoptosis due to radiofrequency-induced adaptive response in mice. Electromagn Biol Med. 2022 Sep 5:1-13. doi: 10.1080/15368378.2022.2117187.

Abstract

This study aims to determine whether exposure to non-ionizing radiofrequency fields could induce an adaptive response (AR) in adult mice and to reveal potential molecular mechanisms triggered by RF-induced AR. The study was performed on 24 adult male Swiss-Albino mice. The average mass of the mice was 37 g. Four groups of adult mice, each consisting of 6, were formed. The radiofrequency group (R) and the adaptive response group (RB) were exposed to 900 MHz of global system for mobile communications (GSM) signal at 0.339 W/kg (1 g average specific absorption rate) 4 h/day for 7 days, while the control group (C) and the bleomycin group (B) were not exposed. 20 minutes after the last radiofrequency field (RF) exposure, the mice in the B and RB groups were injected intraperitoneal (ip) bleomycin (BLM), 37.5 mg/kg. All the animals were sacrificed 30 minutes after the BLM injection. Oxidative damage and antioxidant mechanism were subsequently investigated in the blood samples. Changes in the expression of the genes involved in DNA repair were detected in the liver tissue. TUNEL method was used to determine the apoptosis developed by DNA fragmentation in the liver tissue. The RB group, which produced an adaptive response, was compared with the control group. According to the results, the increase of reactive oxygen species (ROS) in the RB group may have played an important role in triggering the adaptive response and producing the required minimum stress level. Furthermore, tumor suppressor 53(p53), oxo guanine DNA glycosylase (OGG-1) levels responsible for DNA repair mechanism genes expression were increased in conjunction with the increase in ROS. The change in the poly (ADP-ribose) polymerase 1 (PARP-1) and glutathione peroxidase 1 (GPx-1) gene expression were not statistically significant. The antioxidant enzyme levels of superoxide dismutase (SOD), catalase (CAT), and total antioxidant capacity (TAC) were decreased in the group with adaptive response. According to the data obtained from terminal deoxynucleotidyl transferase dUTP nick end labeling (TUNEL) analysis, apoptosis was decreased in the RB group due to the decrease in cell death, which might have resulted from an increase in gene expression responsible for DNA repair mechanisms. The results of our study show that exposure to RF radiation may create a protective reaction against the bleomycin. The minimal oxidative stress due to the RF exposure leads to an adaptive response in the genes that play a role in the DNA repair mechanism and enzymes, enabling the survival of the cell.
https://www.tandfonline.com/doi/full/10.1080/15368378.2022.2117187

2.45 GHZ MICROWAVE RADIATION INDUCED OXIDATIVE STRESS: ROLE OF INFLAMMATORY CYTOKINES IN REGULATING MALE FERTILITY THROUGH ESTROGEN RECEPTOR ALPHA IN GALLUS GALLUS DOMESTICUS

Gupta V, Srivastava R.Biochem Biophys Res Commun. 2022 Sep 8;629:61-70. doi: 10.1016/j.bbrc.2022.09.009.

Abstract

Due to the growing number of gadgets emitting electromagnetic radiation (EMR), particularly microwave (MW) radiation, in our daily lives, it is believed that EMR have both long-term and short-term biological impacts that are quite concerning for avian as well as human health. Due to the negative impact of MW emitting equipment on the biological system this study looks into the mechanistic approach by which low-level of 2.45 GHz MW radiation causes an oxidative stress and inflammatory response in the testes micro-environment which further gets regulated by estrogen receptor alpha (ERα) expression in immature Gallus gallus domesticus leading to male infertility. Two weeks old immature male chickens were exposed to non-thermal low-level 2.45-GHz MW radiation for 2 h/day for 30 days (power density = 0.1264 mw/cm2 and SAR = 0.9978 W/kg). In the exposed group, morphometric examination of the testes revealed decreased testicular weight, volume and gonado- somatic index. Further, histological staining demonstrated a substantial reduction in the diameter of seminiferous tubules in the exposed group as compared to the control. The degree of oxidative stress was also determined showing an increase in oxidative stress parameters after exposure. The radiation exposed testes showed a significant increase in IL-1β immunoreactivity and decline in IL-10 immunoreactivity, indicating a sense of MW radiation-induced oxidative stress-regulated inflammatory response. A substantial reduction in ERα expression was also observed in exposed testes by Western blotting. Our investigations conclude that testes being vulnerable to free radical damage become an easy target organ for MW exposure induced oxidative and inflammatory stress. Therefore it becomes evident that it may cause male infertility in chicks via downregulation of ER-α in testis. https://pubmed.ncbi.nlm.nih.gov/36113179/

THE EFFECT OF ELECTROMAGNETIC RADIATION TRANSMITTED FROM ROUTERS ON ANTIBIOTIC SUSCEPTIBILITY OF BACTERIAL PATHOGENS

Pegios A, Kavvadas D, Zarras K, Mpani K, Soukiouroglou P, Charalampidou S, Vagdatli E, Papamitsou T.J Biomed Phys Eng. 2022 Aug 1;12(4):327-338. doi: 10.31661/jbpe.v0i0.2111-1433.

Abstract

Background: Electromagnetic non-ionizing radiation has both thermal and non-thermal outcomes on biological systems, such as humans, animals, and bacteria.

Objective: This study aimed to investigate the effect of non-ionizing radiofrequency radiation, emitted by Wi-Fi routers, on bacterial strains and the modification of their susceptibility to modern antibiotics.

Material and methods: In this case-control paired study, four bacteria were selected, and one colony from each bacterial strain was exposed to Wi-Fi radiation forming the exposure group. Another set of colonies was not exposed to Wi-Fi radiation, forming the control group. Eight

different antibiotic disks were set on the bacterial plates, and the inhibition zone was measured every 3 h for each colony.

Results: Electromagnetic radiation affects bacterial colonies and their susceptibility to antibiotics. Analysis revealed statistically significant differences, correlated with the bacterial strain, the antibiotic agent, and the time of the exposure, in the inhibition zones, mostly after 6 and 24 h (p-value < 0.05).

Conclusion: A correlation was observed between antibiotic susceptibility and non-ionizing radiofrequency exposure. Studying the effects of radiofrequency radiation on prokaryotic organisms could clarify more complicated cell structures and organisms, such as eukaryotic. Further experiments, in vitro and in vivo, could provide more information about these outcomes and cause experts to discuss the current guidelines of exposure limits.
Open access paper: https://jbpe.sums.ac.ir/article_48472.html

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EFFECTS OF RADIOFREQUENCY EMF FROM MOBILE PHONES AND WI-FI ROUTER ON THE GROWTH RATE AND SUSCEPTIBILITY OF ENTEROCOCCUS FAECALIS TO ANTIBIOTICS

Mortazavi SMJ, Taheri M, Paknahad M, Khandadash S.J Biomed Phys Eng. 2022 Aug 1;12(4):387-394. doi: 10.31661/jbpe.v0i0.1268.

Abstract

Background: During the last decade, people have been dramatically exposed to radiation emitted from widely- used radiofrequency electromagnetic fields (RF-EMF) generating devices.

Objective: This study aimed to evaluate the effects of exposure to RF-EMF emitted from smart phones and Wi-Fi routers on the growth rate and antibiotic sensitivity of Enterococcus faecalis (E. faecalis) as a pathogen in the root canals of teeth.

Material and methods: In this experimental study, E. faecalis ATCC 19115 was used, characterized and confirmed by morphological and biochemical tests. Antibiotic susceptibility test was measured for several common antibiotics. To perform antibiotic susceptibility tests, disk diffusion (Kirby-Bauer) method on Mueller-Hinton agar plates was used before and after exposure to RF-EMFs emitted from a commercial Wi-Fi router or a mobile phone simulator. Moreover, we measured the optical density at 625 nm after different exposure times using a calibrated UV-visible spectrophotometer to evaluate the effect of RF-EMF exposure on the bacterial growth rate.

Results: Exposure to RF-EMF significantly altered the antimicrobial sensitivity of the E. faecalis. While the susceptibility of the bacteria decreased significantly after 6 h of exposure, longer exposure time (e.g. exposure for 24 h) increased the susceptibility of the bacteria to all antibiotics. Furthermore, it was found that the bacteria tended to regress to their early state. Moreover, the non-exposed E. faecalis showed a slower growth rate than the bacteria exposed to RF-EMFs.

Conclusion: Exposure to RF-EMF emitted by Wi-Fi routers or mobile phone simulator can significantly change the antibiotic susceptibility and growth rate of E. faecalis.
Open access paper: https://jbpe.sums.ac.ir/article_47590.html

ELF-MF EXPOSURE, ACTUAL AND PERCEIVED, AND ASSOCIATED HEALTH SYMPTOMS: A CASE STUDY OF AN OFFICE BUILDING IN TEL AVIV-YAFO, ISRAEL

Raz-Steinkrycer LS, Dubnov J, Gelberg S, Jia P, Portnov BA. ELF-MF Exposure, Actual and Perceived, and Associated Health Symptoms: A Case Study of an Office Building in Tel Aviv-Yafo, Israel. Sustainability. 2022; 14(17):11065. https://doi.org/10.3390/su141711065.

Abstract

Empirical studies link exposure to extremely low frequency magnetic fields (ELF-MFs) to several health symptoms. However, it is unclear whether these symptoms are associated with actual or perceived exposure. In this study we attempted to answer this question by studying the health complaints of employees working in a multi-story office building located near a major high-voltage power line. ELF-MF measurements were conducted in the building using a triaxial sensor coil device on all 15 floors. In parallel, questionnaires were administered to evaluate the prevalence of various health symptoms among the employees. Multivariate logistic regressions were used next to quantify the associations between actual and perceived ELF-MF exposure and the employees' health complaints. The analysis revealed that feelings of weakness, headache, frustration, and worry were associated with both measured and perceived ELF-MF exposure ($p < 0.01$), while perceived ELF-MF exposure was also found to be associated with eye pain and irritation (OR = 1.4, 95% CI = 1.2–1.6), sleepiness (OR = 1.3, 95% CI = 1.1–1.5), dizziness and ear pain (OR = 1.2, 95% CI = 1.0–1.4). We conclude that high-voltage power lines produce both physiological and psychological effects in nearby workers, and, hence, proximity to such power lines should become a public health issue.

Conclusions

The main findings of this study can be summarized as follows:

- The analysis revealed no significant association between instrumentally measured and perceived ELF-MF exposure, which implies that individuals cannot detect actual ELF-MF exposure accurately;
- The analysis revealed that feelings of weakness, headache, frustration and worries were associated with both measured and perceived ELF-MF exposure, while perceived ELF-MF exposure was also found to be associated with eye pain and irritation, sleepiness, as well as dizziness and ear pain.
- As we conclude, working near a high voltage power line appears to produce not only psychological but also physiological effects, and should thus become a public health concern.

As several reported symptoms (including headache, frustration/worry, and exhaustion/weakness) were found to be significantly related to measured exposure, not just perceived exposure, the results should lead to revisiting ELF-MF exposure standards. Moreover, follow-up studies should attempt to estimate other effects of ELF-MF exposure, such as its effects on employee productivity, the number of visits to physicians, absenteeism, and medication intake.

Open access paper: https://www.mdpi.com/2071-1050/14/17/11065

EXTREMELY LOW-FREQUENCY ELECTROMAGNETIC FIELD IMPAIRS THE DEVELOPMENT OF HONEYBEE

Li Y, Sun C, Zhou H, Huang H, Chen Y, Duan X, Huang S, Li J. Extremely Low-Frequency Electromagnetic Field Impairs the Development of Honeybee (Apis cerana). Animals (Basel). 2022 Sep 14;12(18):2420. doi: 10.3390/ani12182420.

Abstract

Increasing ELF-EMF pollution in the surrounding environment could impair the cognition and learning ability of honeybees, posing a threat to the honeybee population and its pollination ability. In a social honeybee colony, the numbers of adult bees rely on the successful large-scale rearing of larvae and continuous eclosion of new adult bees. However, no studies exist on the influence of ELF-EMFs on honeybee larvae. Therefore, we investigated the survival rate, body weight, and developmental duration of first instar larvae continuously subjected to ELF-EMF exposure. Moreover, the transcriptome of fifth instar larvae were sequenced for analyzing the difference in expressed genes. The results showed that ELF-EMF exposure decreases the survival rate and body weight of both white-eye pupae and newly emerged adults, extends the duration of development time and seriously interferes with the process of metamorphosis and pupation. The transcriptome sequencing showed that ELF-EMF exposure decreases the nutrient and energy metabolism and impedes the degradation of larvae tissues and rebuilding of pupae tissues in the metamorphosis process. The results provide an experimental basis and a new perspective for the protection of honeybee populations from ELF-EMF pollution.

Open access paper: https://www.mdpi.com/2076-2615/12/18/2420

SUPPRESSION OF GLUCOCORTICOID RESPONSE IN STRESSED MICE USING 50 HZ ELECTRIC FIELD ACCORDING TO IMMOBILIZATION DEGREE AND POSTURE

Harakawa S, Hori T, Hiramoto T, Nedachi T, Shinba T, Suzuki H. Suppression of Glucocorticoid Response in Stressed Mice Using 50 Hz Electric Field According to Immobilization Degree and Posture. Biology (Basel). 2022 Sep 9;11(9):1336. doi: 10.3390/biology11091336.

Abstract

Various studies on immobilized BALB/c mice to evaluate changes in hormone levels associated with stress responses have advanced the characterization of multiple aspects of the biological actions of extremely low- frequency (ELF) electric fields (EFs). In this study, we aimed to investigate the effect of mouse posture on its stress responses and evaluate the importance of adjusting the stress degree in the model. Mice were immobilized inside centrifuge tubes and exposed to an ELF EF generated between parallel plate electrodes. Blood was collected under anesthesia immediately after EF exposure, and plasma glucocorticoids were assayed. The inhibitory effects of EFs on glucocorticoid elevation by immobilization were reproduced regardless of whether mice were in the abdominal or lateral recumbent position, for the EF vector delivered to mice through the sagittal or frontal plane. The effect of ELF EF was reproduced in moderately and mildly stressed mice but not in severely immobilized mice. Hence, adjusting the stress degree is critical to the reproducibility of the results for this model. We characterized the effects of ELF EF on homeostasis, including the stress response, and provided valuable information for the scientific evaluation of the biological risks and medical applications of ELF EF.

Open access paper: https://www.mdpi.com/2079-7737/11/9/1336

MAGNETIC FIELD INTERACTIONS OF SMARTWATCHES AND PORTABLE ELECTRONIC DEVICES WITH CIEDS - DID WE OPEN A PANDORA'S BOX?

Badertscher P, Vergne C, Féry C, Mannhart D, Quirin T, Osswald S, Kühne M, Sticherling C, Knecht S, Pascal J. Magnetic field interactions of smartwatches and portable electronic devices with CIEDs - Did we open a Pandora's box? Int J Cardiol Heart Vasc. 2022 Sep 8;43:101122. doi: 10.1016/j.ijcha.2022.101122.

Abstract

Introduction: Magnetic interaction of portable electronic devices (PEDs), such as state-of-the art mobile phones, with cardiovascular implantable electronic devices (CIEDs) has been reported. The aim of the study was to quantify the magnetic fields of latest generation smartwatches and other PEDs and to evaluate and predict their risk of CIED interactions.

Methods: High resolution magnetic field characterization of five smartwatches (Apple Watch 6/7, Fitbit Sense, Samsung Galaxy 3, Withings Scanwatch) was performed using a novel magnetic field camera. Ex vivo measurements of the minimal safety distance (MSD) at which no mode switch can be observed were performed between 11 PEDs and six representative CIEDs.

Results: Maximal 1 mT distances ranged between 10 mm (Withings) and 19 mm (Fitbit and AppleWatch), and 1 mT volumes between 6 cm3 (Withings) and 19 cm3 (Fitbit). All these measures were observed only for the back side of the smartwatches. While most smartwatches with measured 1 mT distance < 15 mm posed low ex vivo interaction within a distance of < 10 mm, PEDs such as electronic pens and in-ear-headphones with measured 1 mT distance > 15 mm showed device interaction up to > 15 mm. Linear regression analysis showed a linear relationship of the MSD with 1 mT distance (B coefficient: 0.46; 95 %-CI: 0.25-0.67, $p < 0.001$).

Conclusion: Smartwatches are safer compared to other PEDs such as electronic pens or in-ear headphones with regards to CIED interaction. With a standardized magnetic field camera, the risk assessment of CIED interaction of novel PEDs is feasible.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9467892/

RADICAL TRIADS, NOT PAIRS, MAY EXPLAIN EFFECTS OF HYPOMAGNETIC FIELDS ON NEUROGENESIS

Ramsay J, Kattnig DR. Radical triads, not pairs, may explain effects of hypomagnetic fields on neurogenesis. PLoS Comput Biol. 2022 Sep 15;18(9):e1010519. doi: 10.1371/journal.pcbi.1010519.

Abstract

Adult hippocampal neurogenesis and hippocampus-dependent cognition in mice have been found to be adversely affected by hypomagnetic field exposure. The effect concurred with a reduction of reactive oxygen species in the absence of the geomagnetic field. A recent theoretical study suggests a mechanistic interpretation of this phenomenon in the framework of the Radical Pair Mechanism. According to this model, a flavin- superoxide radical pair, born in the singlet spin configuration, undergoes magnetic field-dependent spin dynamics such that the pair's recombination is enhanced as the applied magnetic field is reduced. This model

has two ostensible weaknesses: a) the assumption of a singlet initial state is irreconcilable with known reaction pathways generating such radical pairs, and b) the model neglects the swift spin relaxation of free superoxide, which abolishes any magnetic sensitivity in geomagnetic/hypomagnetic fields. We here suggest that a model based on a radical triad and the assumption of a secondary radical scavenging reaction can, in principle, explain the phenomenon without unnatural assumptions, thus providing a coherent explanation of hypomagnetic field effects in biology.

Author Summary

The hippocampal region of the brain plays a major role in learning and memory functionality. In male mice, shielding of the Earth's magnetic field was found to decrease hippocampal neurogenesis, i.e. the formation of new neurons, following from a decrease in levels of reactive oxygen species. In this study, we suggest an explanation in terms of spin dynamics of a three radical system composed of flavin-semiquinone, superoxide and ascorbyl radical. This model agrees with the experimental data whilst retaining realistic parameters for a biological system, unlike the Radical Pair Mechanism.

Open access paper:
https://journals.plos.org/ploscompbiol/article?id=10.1371/journal.pcbi.1010519

HSP72-BASED EFFECT AND MECHANISM OF MICROWAVE RADIATION-INDUCED CARDIAC INJURY IN RATS

Li D, Xu X, Gao Y, Wang J, Yin Y, Yao B, Zhao L, Wang H, Wang H, Dong J, Zhang J, Peng R. Oxid Med Cell Longev. 2022 Aug 18;2022:7145415. doi: 10.1155/2022/7145415.

Abstract

The purpose of this study was to determine the role of heat shock protein 72 (Hsp72) changes in cardiac injury caused by microwave radiation, aimed at providing novel insights into the mechanism of this damage. A digital thermometer was used to measure the rectal temperature of the rats' pre- and post-radiation. On the 1st, 7th, 14th, and 28th days post-radiation, the changes in electrocardiogram (ECG) were analyzed by a multi-channel physiological recorder. The myocardial enzyme activities and ion concentrations were detected by an automatic biochemical analyzer. Additionally, the levels of myocardial injury markers were established by the enzyme- linked immunosorbent assay (ELISA), and those of hormones were measured by radioimmunoassay. The structure and ultrastructure of the myocardial tissue were observed using an optical microscope and transmission electron microscopy (TEM). The expression of Hsp72 was measured by Western blot and immunofluorescence analyses. Post-exposure, the rectal temperature in the R-group increased significantly, ECG was disordered, and the concentrations of ions were decreased. Furthermore, the activities of myocardial enzymes were changed, and the contents of myocardial injury markers and hormones were increased. We observed damage to the structure and ultrastructure and significantly increased expression of Hsp72. As a whole, the results indicated that S-wave microwave radiation at 30 mW/cm2 for 35 min resulted in damage to the cardiac functionality organigram, caused by a combination of the thermal and nonthermal effects.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9410832

GENOMIC DNA DAMAGE INDUCED BY CO-EXPOSURE TO DNA DAMAGING AGENTS AND PULSED MAGNETIC FIELD

López-Díaz B, Mercado-Sáenz S, Burgos-Molina AM, González-Vidal A, Sendra-Portero F, Ruiz-Gómez MJ. Genomic DNA damage induced by co-exposure to DNA damaging agents and pulsed magnetic field. Int J Radiat Biol. 2022 Sep 7:1-31. doi: 10.1080/09553002.2022.2121873.

Abstract

Purpose: Many articles describe the effects of extremely low-frequency magnetic fields (MF) on DNA damage induction. However, the mechanism of MF interaction with living matter is not yet known with certainty. Some works suggest that MF could induce an increase in the efficacy of Reactive Oxygen Species (ROS) production. This work investigates whether pulsed MF exposure produces alterations in genomic DNA damage induced by co-exposure to DNA damaging agents (bleomycin and methyl methanesulfonate (MMS)).

Materials and methods: Genomic DNA, prepared from S. cerevisiae cultures, was exposed to pulsed MF (1.5 mT peak, 25 Hz) and MMS (0-1%) (15-60 minutes), and to MF and bleomycin (0-0.6 IU/ml) (24-72 hours). The damage induced to DNA was evaluated by electrophoresis and image analysis.

Results: Pulsed MF induced an increment in the level of DNA damage produced by MMS and bleomycin in all groups at the exposure conditions assayed.

Conclusions: Pulsed MF could modulate the cytotoxic action of MMS and bleomycin. The observed effect could be the result of a multifactorial process influenced by the type of agent that damages DNA, the dose, and the duration of the exposure to the pulsed MF.

https://pubmed.ncbi.nlm.nih.gov/36069754/

INVESTIGATION OF FETUIN-A PATHWAY IN DIABETES MELLITUS FORMATION IN RATS EXPOSED TO ELF MAGNETIC FIELDS

Sert C, Delin M, Eren MA, Çakmak Y. Investigation of Fetuin-A pathway in diabetes mellitus formation in rats exposed to elf magnetic fields. Electromagn Biol Med. 2022 Sep 8:1-7. doi: 10.1080/15368378.2022.2117189.

Abstract

The presence of technological devices in our lives has increased exposure to environmental electromagnetic fields. As a result of this, especially Cancer and Diabetes are increasing.Rats were divided into 3 groups with 12 rats in each group. The 1st experimental group (n = 12) was exposed to a 50 Hz ELF magnetic field of 0.4 mT for 6 hours a day for 5 days, the 2nd experimental group (n = 12) was exposed for 10 days, and the control group (n= 12) was never exposed to a magnetic field. After completing the applications, blood collection from the rats was performed under appropriate conditions, measurements were made in the laboratory, and statistical analysis was performed between the groups. There was no significant difference between the groups in the results of transaminases and lipid profiles and C-Peptide. There was no significant difference in insulin, urea, creatinine, Na, K, Ca, and uric acid parameters between the groups. However, there was a significant increase in glucose, HbA1c, and Hba1 IFCC values between the control group and the experimental groups (p <

.001). There was a significant increase in the level of Fetuin-A between the control group and the experimental groups (p <.05). There was an increase in the Fetuin-A, Glucose, HbA1c, and Hba1c IFCC values in both of the experimental groups compared to the control group. We believe that an increase in these values may cause Type 3 diabetes.
https://pubmed.ncbi.nlm.nih.gov/36073511/

BIOLOGICAL EXPERIMENTAL STUDY ON CUMULATIVE EFFECT OF VEHICLE ELECTROMAGNETIC RADIATION

J. Li, W. Changyuan and Z. Yujie.2022 Asia-Pacific International Symposium on Electromagnetic Compatibility(APEMC),2022, pp. 261- 263,

Abstract

Compared with power frequency magnetic field or mobile phone, electric vehicles are equipped with more and more high-voltage components, more and more electronic components, and their frequency, waveform and modulation mode are more flexible, which may make the electromagnetic exposure scene of passengers in the vehicle more complex. With the acceleration of the comprehensive electrification trend of public transport, people are exposed to electric vehicles more and more frequently, and the time is also gradually increasing.

Whether the cumulative effect of vehicle electromagnetic radiation has an impact on occupant health is a matter of general concern to consumers. At present, there is still a lack of relevant research and standards on the cumulative effect of vehicle electromagnetic radiation at home and abroad. In this paper, a pure electric vehicle is taken as the test object, and the test mice are taken as an example to verify whether the cumulative effect of vehicle electromagnetic radiation has an impact on the body weight and blood immune cells of mice. The results showed that there were significant gender differences in body weight. However, the test time needs to be further increased to judge whether the cumulative effect causes the impact.

Conclusion

The results showed that the test had a significant effect on the body weight of female mice. Weight is not only a comprehensive index to measure growth and development, but also an overall response to the operation of various physiological functions of the body. In the past, it has been reported that radiation can cause loss of appetite, affect human endocrine system and slow growth and development. Although the mechanism of this effect is not particularly clear and lack of relevant evidence, it is a problem worthy of attention. However, with the increase of exposure time, the change trend needs to be further verified.

In addition, the environmental noise, temperature and humidity of the exposure group and the control group are slightly different in the design of this test, which may have a certain impact on the test results more or less. Therefore, in order to eliminate the interference of environmental factors, laboratory animal experiments will be carried out later to further verify whether the cumulative effect of vehicle electromagnetic radiation will affect the normal immune function of animals.

https://ieeexploreieeeorg.libproxy.berkeley.edu/stamp/stamp.jsp?tp=&arnumber=9888471&isnumber=9888262

UNVEILING THE SPACE WEATHER DURING THE STARLINK SATELLITES DESTRUCTION EVENT ON 4 FEBRUARY 2022

Dang, T., Li, X., Luo, B., Li, R., Zhang, B., Pham, K., et al. (2022). Unveiling the space weather during the Starlink satellites destruction event on 4 February 2022. Space Weather, 20, e2022SW003152. doi: 10.1029/2022SW003152

Abstract

On 4 February 2022, 38 Starlink satellites were destroyed by the geomagnetic storm, which brought significant financial, aerospace and public influences. In this letter, we reveal the space weather process during 3–4 February 2022 geomagnetic disturbances, from the Sun all the way to the satellite orbiting atmosphere. Initiated by an M1.0 class flare and the following coronal mass ejection (CME), a moderate geomagnetic storm was stimulated on 3rd February by the CME arrival at Earth. Subsequently, another moderate storm was triggered on 4th February by the passage of another CME. Model simulations driven by solar wind show that the first geomagnetic storm induced around 20% atmospheric density perturbations at 210 km altitude on 3rd February. The unexpected subsequent storm on 4th February led to a density enhancement of around 20%–30% at around 210 km. The resulting atmospheric drag can be even larger, since the regional density enhancement was over 60% and the satellite orbits were continuously decaying. This event brings forth the urgent requirements of better understanding and accurate prediction of the space weather as well as collaborations between industry and space weather community.

Open access paper:
https://agupubs.onlinelibrary.wiley.com/share/HIHAVJHGFSXJ7C7MEIVM?target=10.1029/2022SW003152

PROTOCOL FOR A SYSTEMATIC REVIEW OF THE IN VIVO STUDIES ON RADIOFREQUENCY (100 KHZ–300 GHZ) ELECTROMAGNETIC FIELD EXPOSURE AND CANCER

Pinto R, Ardoino L Giardullo P, Villani P, Marino C. Protocol for a systematic review of the in vivo studies on radiofrequency (100 kHz–300 GHz) electromagnetic field exposure and cancer. Syst Rev 11, 29 (2022). https://doi.org/10.1186/s13643-022-01898-4

Abstract

Background An Italian project aims to review the scientific literature on the possible carcinogenicity of radiofrequency (100 kHz–300 GHz) electromagnetic field (RF-EMF) exposure. The ENEA team has to carry out a systematic review of the in vivo studies on this topic.

Objectives Development of a protocol for a systematic review (meta-analysis included) to investigate the potential carcinogenic risk following RF-EMF in vivo exposure to doses above or within legal limits. The aims of this review are (1) to provide a descriptive and, if possible, a quantitative summary of the results of the examined RF-EMF in vivo studies, together with an assessment of the consistency of observations and of the causes of heterogeneity, and (2) to assess the weight of evidence to support or refute the hypothesis of carcinogenic effects caused by RF-EMF exposure and to draw conclusions about the potential for carcinogenicity of RF-EMF exposure.

Methods We will search for relevant studies in electronic academic databases and in the reference list of selected papers and reviews on the topic, including the descriptive reviews on RF-EMF carcinogenic effect carried out by international panels of experts since 2011. The following elements of the PECO question were defined: experimental studies on rodents of both sexes, all ages and species, all genetic backgrounds (Population) exposed to RF-EMF alone, or in combination with other physical or chemical agents (Exposure); only studies reporting outcome data in exposed and sham control groups (Comparison); and all types of cancer with all tumor-related outcome measures (Outcome) will be included.

Only peer-reviewed articles written in English will be considered without limit in the publication date.

Eligibility criteria were defined for papers to be included. A risk of bias assessment will be performed using a tool specifically developed for animal studies. A meta-analysis will be performed, if feasible, for all outcome measures; for subgroup analysis, a minimum of 3 studies per subgroup will be required. If meta-analysis will not be possible, a narrative synthesis of the results will be reported.

Systematic review registration: PROSPERO CRD42020191105
Open access paper:
https://systematicreviewsjournal.biomedcentral.com/articles/10.1186/s13643-022-01898-4

BASE TRANSCEIVER STATION ANTENNA EXPOSURE AND WORKERS' HEALTH

Hosseinali Rangkooy, Afshin Rahmati, Behzad Fouladi Dehaghi. Base transceiver station antenna exposure and workers' health. International Journal of Occupational Safety and Ergonomics. 04 Aug 2022. doi: 10.1080/10803548.2022.2085892.

Abstract

Objectives- With the rapid development of technologies related to the communications industry, human exposure to electromagnetic fields has increased during recent decades. The study aimed at investigating the effect of exposure to waves emitted from the base transceiver stations (BTS) on workers' health.

Methods- 240 workers participated in the study. In order to determine the general health conditions in two groups, along with electromagnetic waves exposure measurement, the general health questionnaire (GHQ) was completed and the data on blood parameters were assessed.

Results- The mean age and job experience in the case and control groups were 34.1 ± 4.8 and 10.1 ± 6 years and 31.6 ± 5.5 and 8.8 ± 7 years, respectively. According to the GHQ results, only anxiety and insomnia subscales showed a significant difference between the two groups. The white blood cell and red blood cell counts in the case and control groups were 6715.6 ± 1591 and 7594 ± 2416, $5.3 \times 106 \pm 4.6 \times 105$ and $5.05 \times 106 \pm 5.39 \times 105$ per ml, respectively. Analysis of the results showed that the difference between the two groups was significant.

Conclusion- The results revealed that blood parameters in the BTS operators showed more changes. Thus, it can be concluded that these health impacts result from occupational exposure to BTS waves. https://doi.org/10.1080/10803548.2022.2085892

SIMULATING THE DISPERSION OF THE ENERGY FLUX DENSITY OF THE ELECTROMAGNETIC FIELD GENERATED BY ANTENNAS FOR MOBILE COMMUNICATIONS

Buckus R, Chlebnikovas A, Strukcinskiene B, Stukas R, Austys D, Caban J, Bogucki M, Sidlauskiene A, Seleviciene V, Kilikevičius A, Matijošius J, Kilikevičienė K, Vainorius D. Simulating the Dispersion of the Energy Flux Density of the Electromagnetic Field Generated by Antennas for Mobile Communications. Electronics. 2022; 11(15):2431. https://doi.org/10.3390/electronics11152431.

Abstract

The last two decades have faced a significantly increased number of telecommunication antennas emitting electromagnetic radiation in residential areas. The theoretical simulation of the dispersion of the energy flux density of the electromagnetic field has been performed applying the physical peculiarities of the waves generating electromagnetic radiation. Having evaluated studies on simulation, the visual representation of the spread of electromagnetic radiation has been carried out according to the results obtained applying the AutoCad package. A comparison of the simulated value of the energy flux density radiated from antennas for mobile telecommunications with the measured one has disclosed an overlap of 30%. The simulation of the energy flux density showed that, in the close proximity zone (under a distance of 30 m), antennas radiate values within the range 10–10,000 μW/cm2. At a distance larger than 30 m, the values of energy flux density fluctuate from 10 to 0.001 μW/cm2.

Conclusions

The simulation of the energy flux density of the electromagnetic field allows estimating electromagnetic radiation emitted by antennas for mobile telecommunications, which results in the termination of the conducted experiments. A comparison of the simulated value of the energy flux density radiated from antennas for cell telecommunications with the measured one point to an overlap of 30%, because simulation encounters difficulties in precisely measuring a variety of natural and human-made obstacles and reflections. Thus, the properly selected simulation software allows understanding and preliminarily estimating the electromagnetic fields of mobile telecommunications as well as visually determining places where electromagnetic radiation exceeds the established standards.

The simulation of the energy flux density of the electromagnetic field of antennas for mobile telecommunications showed that, in the close proximity zone (under a distance of 30 m), antennas radiate values from 10 to 10,000 μW/cm2, whereas the values fluctuate between 10 and 0.001 μW/cm2 at a distance larger than 30 m. The values of the energy flux density of the electromagnetic field decrease according to square dependence in free space, while at distances exceeding 100 m fluctuate in the range from 0.01 to 1 μW/cm2. The maximum density was equal to 10–100 μW/cm2 under the distance less than 25 m from the antenna in the direction of the most intensive radiation.

The examination of the upcoming or available antenna or other powerful source of radio waves includes calculating the theoretical parameters of the density taking into account the qualities of the antenna and accepting surrounding terrain as an area with no significant unevenness. Similar places have most frequently installed antennas, and, although the obtained measurement results are satisfactory enough, in order to determine necessary safety requirements, the impact of land relief is unnecessarily downgraded. The wave propagated outwards the antenna is dispersed and, having reflected from terrain, is summed up with the previous one, thus creating a maximum. Uneven terrain changes the maximum position of this electromagnetic field, which needs further examination. Thus, if the simulated values are lower than the established standard, it is still advisable to check them experimentally.

Open access paper: https://www.mdpi.com/2079-9292/11/15/2431/htm

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MICROWAVE RADIATION AND THE BRAIN: MECHANISMS, CURRENT STATUS, AND FUTURE PROSPECTS

Mumtaz S, Rana JN, Choi EH, Han I. Microwave Radiation and the Brain: Mechanisms, Current Status, and Future Prospects. International Journal of Molecular Sciences. 2022; 23(16):9288. https://doi.org/10.3390/ijms23169288

Abstract

Modern humanity wades daily through various radiations, resulting in frequent exposure and causing potentially important biological effects. Among them, the brain is the organ most sensitive to electromagnetic radiation (EMR) exposure. Despite numerous correlated studies, critical unknowns surround the different parameters used, including operational frequency, power density (i.e., energy dose), and irradiation time that could permit reproducibility and comparability between analyses. Furthermore, the interactions of EMR with biological systems and its precise mechanisms remain poorly characterized. In this review, recent approaches examining the effects of microwave radiations on the brain, specifically learning and memory capabilities, as well as the mechanisms of brain dysfunction with exposure as reported in the literature, are analyzed and interpreted to provide prospective views for future research directed at this important and novel medical technology for developing preventive and therapeutic strategies on brain degeneration caused by microwave radiation. Additionally, the interactions of microwaves with biological systems and possible mechanisms are presented in this review. Treatment with natural products and safe techniques to reduce harm to organs have become essential components of daily life, and some promising techniques to treat cancers and their radioprotective effects are summarized as well. This review can serve as a platform for researchers to understand the mechanism and interactions of microwave radiation with biological systems, the present scenario, and prospects for future studies on the effect of microwaves on the brain.

Open access paper: https://www.mdpi.com/1422-0067/23/16/9288

SPECIFIC ABSORPTION RATE ANALYSIS OF SMARTPHONE

M. Garvanova, I. Garvanov, D. Borissova. Specific Absorption Rate Analysis of Smartphone. 2022 22nd International Symposium on Electrical Apparatus and Technologies (SIELA), 2022, pp. 1-4, doi: 10.1109/SIELA54794.2022.9845756.

Abstract

This paper discusses and analyzes the process of absorbing electromagnetic energy emitted by a smartphone. The study of the specific absorption rate (SAR) at the depth of the human head was carried out using a computer model simulated with COMSOL Multiphysics software. The computer model takes into account the technical parameters of a working smartphone and the biological characteristics of the human head. The model simulates the absorption process, depending on the type of radiation pattern of the antenna on a smartphone. To validate the results of the model in depth of the human head, an analysis of the brain activity of a person, using a smartphone, was performed.

Excerpts

This study confirms the hypothesis that prolonged use of mobile phones changes a person's brain activity, which may be a prerequisite for fatigue, distraction and stress of the body. This study largely confirms the assumption that SAR affects brain activity, but further research is needed in this direction....

In the places with the greatest absorption of electromagnetic energy, the most significant change in brain activity is observed. Here, statistically significant differences in the theta, alpha and beta ranges of the EEG signal were obtained, established by paired samples t-test. The results with p-values less than 0.05 indicate statistically significant differences in EEG power in T3 (θ, a, and β), T5 (θ and a), and F7 (θ and a) points as shown in Figure 6.

From the computer model for SAR (Fig. 7), it can be seen that the locations with the highest absorption levels of the electromagnetic field coincide with the locations of the most significant change in the spectrum of the EEG signals. Due to the computer model for simulating SAR from an EMF, it can be physically explained why a change in the signal spectrum occurs at several points in the human head. With the help of the computer model it is possible to study the effects of elevated values of electromagnetic radiation, which can be harmful to human health. Through the model it is also possible to visualize invisible processes that predict various negative effects from prolonged use of a mobile phone....

Conclusions

This article examines the SAR caused by the use of a smartphone. The EMF absorption level at the depth of the human head is simulated using a computer model. Depending on the parameters of the smartphone and the characteristics of the tissues of the human head, different SAR results are obtained. The computer model was tested by processing the EEG signals and analyzing the spectra of the EEG signals from all electrodes. It is interesting that the results of the model coincide with the results of the EEG analysis. The places with the highest EMF absorption values coincided with the places of greatest change in brain activity induced by smartphone operation. In our future research, we will focus on the analysis of the excessive use of smartphones by children and adolescents.

https://ieeexplore.ieee.org/document/9845756

INTERFERENCE WITH IMPLANTED UPPER AIRWAY STIMULATION DEVICE BY PHONES WITH MAGNET TECHNOLOGY (IPHONES 12 AND 13)

Plawecki A, Tripathi N, Tovar Torres M, Yaremchuk K. Interference with Implanted Upper Airway Stimulation Device by Phones with Magnet Technology. Laryngoscope. 2022 Aug 17. doi: 10.1002/lary.30348.

Abstract

Newer iPhone models [12 and 13] with MagSafe magnetic technology can cause electromagnetic interference with the Inspire upper airway stimulator device (a surgical implant for the treatment of obstructive sleep apnea).

https://www.ncbi.nlm.nih.gov/pubmed/35975894

SIMULATING THE DISPERSION OF THE ENERGY FLUX DENSITY OF THE ELECTROMAGNETIC FIELD GENERATED BY ANTENNAS FOR MOBILE COMMUNICATIONS

Buckus R, Chlebnikovas A, Strukcinskiene B, Stukas R, Austys D, Caban J, Bogucki M, Sidlauskiene A, Seleviciene V, Kilikevičius A, Matijošius J, Kilikevičienė K, Vainorius D. Simulating the Dispersion of the Energy Flux Density of the Electromagnetic Field Generated by Antennas for Mobile Communications. Electronics. 2022; 11(15):2431. doi:10.3390/electronics11152431.

My note: The FCC exposure limit is 1 mW/cm2 or 1000 µW/cm2 which means within 30 meters of a cellular antenna the electromagnetic field could be up to 10 times the limit at some locations.

Abstract

The last two decades have faced a significantly increased number of telecommunication antennas emitting electromagnetic radiation in residential areas. The theoretical simulation of the dispersion of the energy flux density of the electromagnetic field has been performed applying the physical peculiarities of the waves generating electromagnetic radiation. Having evaluated studies on simulation, the visual representation of the spread of electromagnetic radiation has been carried out according to the results obtained applying the AutoCad package. A comparison of the simulated value of the energy flux density radiated from antennas for mobile telecommunications with the measured one has disclosed an overlap of 30%. The simulation of the energy flux density showed that, in the close proximity zone (under a distance of 30 m), antennas radiate values within the range 10–10,000 µW/cm2. At a distance larger than 30 m, the values of energy flux density fluctuate from 10 to0.001 µW/cm2.

Conclusions

The simulation of the energy flux density of the electromagnetic field allows estimating electromagnetic radiation emitted by antennas for mobile telecommunications, which results in the termination of the conducted experiments. A comparison of the simulated value of the energy flux density radiated from antennas for cell telecommunications with the measured one point to an overlap of 30%, because simulation encounters difficulties in precisely measuring a variety of natural and human-made obstacles and reflections. Thus, the properly selected simulation software allows understanding and preliminarily estimating the

electromagnetic fields of mobile telecommunications as well as visually determining places where electromagnetic radiation exceeds the established standards.

The simulation of the energy flux density of the electromagnetic field of antennas for mobile telecommunications showed that, in the close proximity zone (under a distance of 30 m), antennas radiate values from 10 to 10,000 μW/cm2, whereas the values fluctuate between 10 and 0.001 μW/cm2 at a distance larger than 30 m. The values of the energy flux density of the electromagnetic field decrease according to square dependence in free space, while at distances exceeding 100 m fluctuate in the range from 0.01 to 1 μW/cm2. The maximum density was equal to 10–100 μW/cm2 under the distance less than 25 m from the antenna in the direction of the most intensive radiation.

The examination of the upcoming or available antenna or other powerful source of radio waves includes calculating the theoretical parameters of the density taking into account the qualities of the antenna and accepting surrounding terrain as an area with no significant unevenness. Similar places have most frequently installed antennas, and, although the obtained measurement results are satisfactory enough, in order to determine necessary safety requirements, the impact of land relief is unnecessarily downgraded. The wave propagated outwards the antenna is dispersed and, having reflected from terrain, is summed up with the previous one, thus creating a maximum. Uneven terrain changes the maximum position of this electromagnetic field, which needs further examination. Thus, if the simulated values are lower than the established standard, it is still advisable to check them experimentally

Open access paper: https://www.mdpi.com/2079-9292/11/15/2431/htm

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REGULAR MEASUREMENTS OF EMF IN A REPRESENTATIVE NORWEGIAN CITY-CONSTANT EXPOSURE OVER TIME DESPITE INTRODUCTION OF NEW TECHNOLOGIES

Markussen AC, Sjoemoen TM, Unander EH, Klaeboe L. Regular measurements of EMF in a representative Norwegian city-constant exposure over time despite introduction of new technologies. Environ Monit Assess. 2022 Aug 19;194(10):694. doi: 10.1007/s10661-022-10231-4.

Abstract

The rapid growth of the wireless communication industry has resulted in the installation of numerous base stations, everywhere in our surroundings. The population is exposed to Radio Frequency Electromagnetic Fields of varying frequency and strength. This, and introduction of new systems have risen public concerns regarding potential health effects from this RF-EMF exposure. The purpose of this project is to get an overview of any changes in exposure when new technologies are introduced. From June 2013 to October 2019, measurements were made at 16 measurement points in Kristiansand and surrounding areas in the same order, on the same day of the week and at the same time of day. The measurements are performed on the frequency bands 390, 450, 800, 900, 1800, 2100, 2400, and 2600 MHz. When we summed up the exposure for all the frequency bands relative to the limit values in a measuring point, the total values per measuring point showed that the exposure outdoors in most cases is less than 1‰ of the limit value. In 2017, a temporary increase was registered for most measurement points, but during 2018 the levels returned to the levels registered before 2017. During the increase, the levels were still low, around 3‰ of the limit values. The

increase may be due to the fact that two mobile operators during this period made a comprehensive reconfiguration of their networks. The measurements presented in this report show that the exposure of the population is low, thousandths of the limit values, and relatively constant over time even though new technologies are introduced.
Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9391237/

COMMENTS ON MEASUREMENTS AND ANALYSIS OF PERSONAL EXPOSURE TO RF-EMF INSIDE AND OUTSIDE SCHOOL BUILDINGS

E. Arribas, R. Ramirez-Vazquez, I. Escobar. Comments on “Measurements and Analysis of Personal Exposure to RF-EMF Inside and Outside School Buildings: A Case Study at a Kosovo School." IEEE Access, 2022, doi: 10.1109/ACCESS.2022.3198975.

Abstract

In this comment we present a table with the measurements of the personal exposure in the two Wi-Fi frequency bands inside educational centers such as colleges and universities, in different countries, with the aim of complementing and comparing the measurements carried out in a large school in the city of Pristina, Kosovo.

We obtained that the maximum value was recorded in Spain with 120 μW/m2 and the minimum value was recorded in Switzerland with 1.19 μW/m2. The mean value of the data in Table 2 is 36.9 μW/m2, the median is 22.2 μW/m2, and the 95th percentile is 110 μW/m2.
https://ieeexplore.ieee.org/document/9772682

TRENDS IN BRAIN CANCERS (GLIOMA) IN NEW ZEALAND FROM 1995 TO 2020, WITH REFERENCE TO MOBILE PHONE USE

My note: The study has several shortcomings: (1) it did not examine incidence rates over time for Glioblastoma (GBM), the most common type of glioma (brain cancer). Phillips et al (2018) found that GBM increased substantially over time in England despite a flat trend for glioma. (2) The authors combined temporal and parietal lobe tumors and examined the incidence over time. Their rationale was that these lobes received the most exposure to cell phone radiation; however, Cabré-Riera et al (2020) found that the temporal and frontal lobes received the most exposure; the parietal lobe received the least exposure.

Philips et al (2018). Brain Tumours: Rise in Glioblastoma Multiforme Incidence in England 1995–2015 Suggests an Adverse Environmental or Lifestyle Factor. Journal of Environmental and Public Health, doi:10.1155/2018/7910754. Cabré-Riera et al (2020). Estimated whole-brain and lobe-specific radiofrequency electromagnetic fields doses and brain volumes in preadolescents. Environ Int. 142:105808. doi:10.1016/j.envint.2020.105808. J Mark Elwood, Shwe Sin Win, Phyu Sin Aye, Masoumeh Sanagou. Trends in brain cancers (glioma) in New Zealand from 1995 to 2020, with reference to mobile phone use. Cancer Epidemiol. 2022 Aug 9;80:102234. doi: 10.1016/j.canep.2022.102234.

Highlights

- Hypothesis is that mobile phone use increases brain cancers such as glioma.
- Mobile phone use in New Zealand increased greatly between 1990 and 2006.
- Incidence of glioma from 1995 to 2020 showed no increase at ages 10–69
- No evidence that phone use increases risk even after many years.

Abstract

Background: Some case-control studies have suggested substantial increased risks of glioma in association with mobile phone use; these risks would lead to an increase in incidence over time.

Methods: Incidence rates of glioma from 1995 to 2020 by age, sex, and site in New Zealand (NZ) recorded by the national cancer registry were assessed and trends analysed. Phone use was based on surveys.

Results: In these 25 years there were 6677 incident gliomas, giving age-standardised rates (WHO world standard) of 6.04 in males, and 3.95 in females per 100,000. The use of mobile phones increased rapidly from 1990 to more than 50% of the population from about 2000, and almost all the population from 2006. The incidence of glioma from ages 10-69 has shown a small decrease over the last 25 years, during which time the use of mobile phones has become almost universal. Rates in the brain locations receiving most radiofrequency energy have also shown a small decrease. Rates at ages of 80 and over have increased.

Conclusion: There is no indication of any increase related to the use of mobile phones. These results are similar to results in Australia and in many other countries. The increase in recorded incidence at ages over 80 is similar to that seen in other countries and consistent with improved diagnostic methods.

Excerpts

In contrast, the incidence of glioma at ages 70 and over has shown a substantial increase over time (Fig. 5), the annual percentage changes being in males 1.5% (95% limits 0.3–2.8), and in females 1.3% (95% limits 0.3–2.3). The increase has been regular throughout the 1995–2020 period in females. In men, the rates rose more quickly from 1995 to 2011, and have since declined: however, this change is not significant and a linear increase gives the best fit to the data.

Further examination shows that the increase is significant in the 80–84 and 85 + age groups, while the 70–74 and 75–79 year old groups show no significant increase (Fig. 6, Table 2). These older groups have a lower incidence of glioma than the 75–79 and 70–75 year old groups, but their rising rates have reduced this difference over time.

In conclusion, the incidence of glioma in the New Zealand population from ages 10–69 has shown a small decrease over the last 25 years, during which time the use of mobile phones has become almost universal. There is no indication of any increase related to the use of mobile phones. There has been an increase in recorded incidence at ages over 80, similar to that seen in other countries and consistent with improved diagnostic methods.

https://pubmed.ncbi.nlm.nih.gov/35961280/

TIME TRENDS IN MOBILE PHONE USE AND GLIOMA INCIDENCE AMONG MALES IN THE NORDIC COUNTRIES, 1979-2016

Isabelle Deltour, Aslak Harbo Poulsen, Christoffer Johansen, Maria Feychting, Tom Børge Johannesen, Anssi Auvinen, Joachim Schüz. Time trends in mobile phone use and glioma incidence among males in the Nordic Countries, 1979-2016. Environment International. 2022. 107487. doi:10.1016/j.envint.2022.107487.

Abstract

Introduction In the Nordic countries, the use of mobile phones increased sharply in the mid-1990s especially among middle-aged men. We investigated time trends in glioma incidence rates (IR) with the perspective to inform about the plausibility of brain tumour risks from mobile phone use reported in some case-control studies.

Methods We analysed IR of glioma in Denmark, Finland, Norway, and Sweden among men aged 40-69 years, using data from national cancer registries and population statistics during 1979-2016, using log-linear joinpoint analysis. Information on regular mobile phone use and amount of call-time was obtained from major studies of mobile phones in these countries. We compared annual observed incidence with that expected under various risk scenarios to assess which of the reported effect sizes are compatible with the observed IR. The expected numbers of cases were computed accounting for an impact of other factors besides mobile phone use, such as improved cancer registration.

Results Based on 18,232 glioma cases, IR increased slightly but steadily with a change of 0.1% (95%CI 0.0%, 0.3%) per year during 1979-2016 among 40–59-year-old men and for ages 60-69, by 0.6 % (95%CI 0.4, 0.9) annually. The observed IR trends among men aged 40-59 years were incompatible with risk ratios (RR) 1.08 or higher with a 10-year lag, RR ≥ 1.2 with 15-year lag and RR ≥ 1.5 with 20-year lag. For the age group 60-69 years, corresponding effect sizes RR ≥ 1.4, ≥ 2 and ≥ 2.5 could be rejected for lag times 10, 15 and 20 years.

Discussion This study confirms and reinforces the conclusions that no changes in glioma incidence in the Nordic countries have occurred that are consistent with a substantial risk attributable to mobile phone use. This particularly applies to virtually all reported risk increases reported by previous case-control studies with positive findings.

Excerpts

"Our analyses are based on 18,232 male glioma cases, which occurred in the male population aged 40-69 years in Denmark, Finland, Norway and Sweden with 162 million person-years at risk. Rates of glioma showed a slow and constant increase with no marked changes in the trend in the recent years."

"... our study also has some limitations. The exposure prevalence was obtained from two sources with different recruitment methods, age and questionnaire characteristics; the prevalence in the age group 60-69 years was less accurately registered than for the age group 40-59 years, because both studies had small sample sizes in this age range at recruitment, and in addition, the data had to be extrapolated for the distant past. Therefore, using these estimates of exposure prevalence could at best provide a range of possible exposure distributions in the population. The use of hands-free devices was not accounted for, but this

was not frequent in these populations (data not shown). Our study is not free of assumptions. The induction period for an effect of mobile phone use on glioma risk, if one exists, is unknown, as is the magnitude of the risk, if any, and the real patterns may be more complex than the scenarios that we simulated. In addition, there are several factors that we were not able to account for. The coverage of the Nordic cancer registries was not perfectly complete, some 1.5% to 10% of the malignant brain tumours were missed in these age groups, but there is no reason to believe this proportion has increased over time. In Sweden, it has been estimated that completeness would not have changed over the period 1998-2014 for the age group 20-69 years, but has increased among ≥70 year olds; completeness might have improved in the other countries due to introduction of automated registration routines (Tettamanti et al., 2019, Gjerstorff, 2011, Leinonen et al., 2017, Larsen et al., 2009). Our analyses incorporated the possibility that other, currently unknown, risk factors, as well as improvement in glioma detection and reporting had a smooth, gradual impact, over the period 1979−2016, consistent with the gradually increasing IRs."

"Our findings indicate that glioma incidence trends among men aged 40-59 years in the Nordic countries are not consistent with increased risks of moderate effect size (RR>1.2-1.4) assuming latency up to 20 years. This means that increased risks reported in some case-control studies are implausible and likely attributable to biases and errors in self-reported use of mobile phone. Our results were consistent with results from prospective cohort studies showing no association between mobile phone use and risk of glioma.

Funding: This study was supported by the German Federal Office for Radiation Protection (BfS; grant FM 8867)."
https://www.sciencedirect.com/science/article/pii/S0160412022004147

5G ELECTROMAGNETIC RADIATION ATTENUATES SKIN MELANOGENESIS IN VITRO BY SUPPRESSING ROS GENERATION

Kim K, Lee YS, Kim N, Choi H-D, Lim K-M. 5G Electromagnetic Radiation Attenuates Skin Melanogenesis In Vitro by Suppressing ROS Generation. Antioxidants. 2022; 11(8):1449. https://doi.org/10.3390/antiox11081449

Abstract

Recently, the impacts of 5G electromagnetic radiation (EMR) with 28 GHz on human health have been attracting public attention with the advent of 5G wireless communication. Here, we report that 5G (28 GHz) EMR can attenuate the skin pigmentation in murine melanoma cells (B16F10) and a 3D pigmented human epidermis model (Melanoderm™). B16 cells were exposed to 5G (28 GHz) with or without α-MSH for 4 h per day.

Interestingly, 5G attenuated α-MSH-induced melanin synthesis. Fontana–Masson staining confirmed that the dendritic formation of α-MSH stimulated B16 cells was diminished by 5G exposure. To confirm the anti- melanogenic effect of 5G EMR, MelanoDerm™ was irradiated with 5G at a power intensity of 10 W/m2 for 4 h a day for 16 days and melanin distribution was detected with Fontana–Masson staining, which supported the anti- melanogenic effect of 5G EMR. Consistently, 5G EMR suppressed α-MSH induced upregulation of melanogenic enzymes; tyrosinase, TRP-1, and TRP-2. Of note, 5G EMR attenuated ROS production

stimulated by α-MSH and H2O2, suggesting that 5G EMR may dissipate ROS generation, which is pivotal for the melanin synthesis.

Collectively, we demonstrated that 5G EMR can attenuate skin pigmentation by attenuating ROS generation. Open access paper: https://www.mdpi.com/2076-3921/11/8/1449

AN IN VITRO EXPERIMENTAL SYSTEM FOR 5G 3.5 GHZ EXPOSURES

Y. S. Lee, S. B. Jeon, J. -K. Pack, N. Kim and H. -D. Choi. An In Vitro Experimental System for 5G 3.5 GHz Exposures. IEEE Access, 2022, doi: 10.1109/ACCESS.2022.3204055.

Abstract

In this study, an in vitro experimental system is developed for fifth-generation (5G) 3.5 GHz exposures. A radial transmission line (RTL) housed in an incubator can support the single-mode propagation at a 3.5 GHz band. A conical antenna is also placed at the center of an RTL to ensure field symmetries. A 5G signal generator along with a customized power amplifier can create 5G new radio time division duplex (TDD) waveforms. Additionally, a feedback scheme implemented by employing a directional coupler and power meter allows power control to ensure a steady output power. The system is evaluated based on temperature measurements using the initial temperature slope and nonlinear curve fitting to determine the specific absorption rate (SAR) values. Comparing SARs obtained from a "worst-case" signal of a maximum power condition with the values obtained from a "TDD" signal of an actual 5G TDD transmission gives the initial slope ratio of 0.741, which is very similar to the theoretical duty cycle of 0.743. It is also shown that the average output power, water temperature, incubator air temperature, and CO2 density are adequately controlled for appropriate in vitro experiments. https://ieeexplore.ieee.org/document/9875270

PILOT STUDY OF A NEW METHODOLOGY TO STUDY THE DEVELOPMENT OF THE BLUE BOTTLE FLY UNDER EXPOSURE TO RADIO- FREQUENCY FIELDS AT 5.4 GHZ

My note: The SAR for the 19.4 V/m exposure condition was estimated to be 0.028 W/kg. At this SAR, the median delay in pupal emergence was twice as long as in the sham condition. Yet, this full-body SAR is less than the so- called 50-fold safety limit of 0.08 W/kg of full body exposure adopted by the FCC and ICNIRP. Thus, along with numerous other biological studies, this pilot study suggests that current safety limits are not adequate across different species.

De Paepe S, De Borre E, Toribio Carvajal D, Bell D, Thielens A. Pilot Study of a New Methodology to Study the Development of the Blue Bottle Fly (Calliphora vomitoria) Under Exposure to Radio-Frequency Electromagnetic Fields at 5.4 GHz. Int J Radiat Biol. 2022 Aug 17:1-49. doi: 10.1080/09553002.2022.2113838.

Abstract

Purpose – Exposure of insects to radio-frequency electromagnetic fields (RF-EMFs) can have developmental effects. However, there is currently no clear understanding of the exposure level that can lead to such effects. Therefore, the goal of this study was to, for the first time, study the development of the Blue Bottle Fly (Calliphora vomitoria, CV) under exposure to RF-EMFs at 5.4 GHz, using both numerical RF-EMF dosimetry with anatomically accurate 3D models of insects and an RF-EMF exposure experiment.

Materials and Methods - CV was chosen as a model organism in this study because CV's development can be influenced thermally and CV's pupal stage presents a window of several days in which immobile pupae can be exposed to RF-EMFs. The 5.4 GHz frequency was used because it allowed us licence-free operation of the exposure setup. Numerical, EM simulations with 3D anatomically accurate models of CV, obtained using micro- CT scanning, were used in this study. These simulations enable the estimation of the absorbed power and the whole-body averaged specific absorption rate in CV during RF exposure experiments. An experiment with three exposure conditions was designed and executed in which 400 pupae were split into an exposed group that was placed inside the TEM cell for 48 h and a concurrent control. Two exposure conditions used RF-EMF input power into the TEM cell at 5.4 GHz on two different levels. One exposure condition was a sham exposure. Electric field strength measurements were used to validate the proper functioning of the exposure setups and to quantify the RF-EMF exposure of the control groups.

Results and Conclusions - All studied groups of pupae – exposed to RF-EMFs, sham, and control groups- showed similar (evolutions of) masses, lengths and diameters during their development. The total rate of pupal emergence was reduced in one of the studied RF-EMF exposures in comparison to its concurrent control, while the other RF-EMF exposure and the sham exposure did not alter the total rate of pupal emergence. The sham exposure and the lowest of the two studied RF-EMF exposure conditions (19.4 V/m) caused a median delay in pupal emergence of 4 and 8 hours, respectively, in comparison to concurrent control groups. The higher studied exposure of 55 V/m caused a median relative acceleration in development of 8 h. https://pubmed.ncbi.nlm.nih.gov/35976063/

EFFECT OF RFEMR ON NSE AND MDA LEVELS IN SPRAGUE DAWLEY RATS

Pagadala, P; Shankar, V and Sumathi, ME. Effect of RFEMR on NSE and MDA levels in Sprague Dawley rats. Jun 2022. Bioinformation.18 (6): 501-505.

Abstract

Radiofrequency emitted radiations (RFEMR) from mobile phones are known to produce a stress response because of its effect on hypothalamus. Mobile phones have become an integral part of our lives with increasing usage not only in terms of number of users but also increase in talk time. Therefore, it is of interest to study the effect of mobile phone radiofrequency electromagnetic radiations on NSE and MDA levels in SD rats. Twelve male SD rats of 10-12weeks old, weighing 180-220 grams, were purchased from registered laboratory breeders & housed in a room with 12:12hour's light-dark cycle with adlibitum amount of food and RO water. Present study showed significant increase in NSE and MDA levels in rats exposed to RFEMR. This study proves that mobile RFEMR causes oxidative stress and oxidative damage in SD rats. http://www.bioinformation.net/018/97320630018501.htm

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ASSESSMENT OF COMBINED EXPOSURE TO INTERMEDIATE-FREQUENCY ELECTROMAGNETIC FIELDS AND PULSED ELECTROMAGNETIC FIELDS AMONG LIBRARY WORKERS IN JAPAN

Yamaguchi-Sekino S, Taki M, Ikuyo M, Esaki K, Aimoto A, Wake K, Kojimahara N. Assessment of combined exposure to intermediate-frequency electromagnetic fields and pulsed electromagnetic fields among library workers in Japan. Front Public Health. 2022 Jul 28;10:870784. doi: 10.3389/fpubh.2022.870784.

Abstract

Objective: To assess exposure levels to electromagnetic fields (EMFs) among library workers in Japan, focusing on co-exposure to intermediate-frequency EMF (IF-EMF) and pulsed EMF, to propose a new epidemiological research methodology.

Methods: The evaluated exposure sources were an electromagnetic type-electronic article surveillance gate (EM-EAS, IF-EMF (operating frequency 220 Hz-14 kHz)) and an activator/deactivator of anti-theft tags termed as "book check unit" (BCU, pulsed EMF). Short-term exposures were: (E1) whole-body exposure from the EAS gate when sitting within 3 m; (E2) local exposure to transient IF-EMF while passing through or beside the EAS gate; and (E3) local exposure to a pulsed magnetic field on BCU use. E1-E3 were evaluated based on exposure levels relative to magnetic flux density at the occupational reference level (RL; E1) or as per occupational basic restrictions (BR; E2 and E3) delineated by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) 2010 guidelines. Exposure indices based on mid-term exposure (D1-D3), assuming exposure according to employment on a weekly basis, were used to assess exposure in actual working conditions. D1 represents continuous exposure from an EAS gate when sitting within 3 m of the gate. D2 and D3 represent repeated transient exposures occurring during gate pass or on the operation of a BCU. A link to a web-based questionnaire was distributed to librarians working at all libraries where the authors had mailed institutional questionnaires (4,073 libraries). Four exposure patterns were defined according to various exposure scenarios.

Results: We obtained information on exposure parameters and working conditions from the 548 completed questionnaires. The ICNIRP guideline levels were not exceeded in any of the E1-E3 scenarios. Median of the D1 (% ICNIRP RL × hour/week) was 1, and >85% respondents had values <10. However, the maximum value was 513. Altogether, these results indicate that continuous exposure was low in most cases. The same tendency was observed regarding repeated transient exposure from EM-EAS gates (i.e., the median value for D2 (% ICNIRP BR × gate pass) was 5). However, there were several cases in which D1 and D2 values were >10 times the median. The median of D3 (% ICNIRP BR × BCU operation) was 10, and most respondents' D3 values were greater than their D2 values, although the derived results depended on the assumptions made for the estimation.

Conclusion: We conducted an assessment of combined exposures to IF-EMF and pulsed EMF among library workers in Japan by evaluating both short-term exposures (E1-E3) and exposure indices based on mid-term exposures (D1-D3) assuming actual working conditions per questionnaire results. These results provide useful information for future epidemiological studies.

Open access paper: https://www.frontiersin.org/articles/10.3389/fpubh.2022.870784/full

EFFECT OF OCCUPATIONAL EXTREMELY LOW-FREQUENCY ELECTROMAGNETIC FIELD EXPOSURE ON THE THYROID GLAND OF WORKERS: A PROSPECTIVE STUDY

Fang YY, Tu Q, Zhang YT, Liu J, Liu HG, Zhao ZH, Wu H, Yin TJ. Effect of Occupational Extremely Low-Frequency Electromagnetic Field Exposure on the Thyroid Gland of Workers: A Prospective Study. Curr Med Sci. 2022 Aug;42(4):817-823. doi: 10.1007/s11596-022-2610-8.

Abstract

Objective: The aim of this study was to investigate the biological effects of occupational extremely low- frequency electromagnetic field (ELF-EMF) exposure on the thyroid gland.

Methods: We conducted a prospective analysis of 85 workers (exposure group) exposed to an ELF-EMF (100 μT, 10-100 Hz) produced by the electromagnetic aircraft launch system and followed up on thyroid function indices, immunological indices, and color Doppler images for 3 years. Additionally, 116 healthy volunteers were randomly selected as controls (control group), the thyroid function of whom was compared to the exposure group.

Results: No significant difference was observed in thyroid function between the exposure and control groups. During the follow-up of the exposure group, the serum free triiodothyronine (FT3) level was found to slowly decrease and free thyroxine (FT4) level slowly increase with increasing exposure time. However, no significant difference was found in thyroid-stimulating hormone (TSH) over the three years, and no significant difference was observed in the FT3, FT4 and TSH levels between different exposure subgroups. Furthermore, no significant changes were observed in thyroid autoantibody levels and ultrasound images between subgroups or over time.

Conclusion: Long-term exposure to ELF-EMF may promote thyroid secretion of T4 and inhibit deiodination of T4 to T3. ELF-EMF has no significant effect on thyroid immune function and morphology. https://pubmed.ncbi.nlm.nih.gov/35963949/

Excerpt

One of the currently popular research topics is whether thyroid cancer can be induced by long-term ELF-EMF exposure. As we know, cancer is caused by DNA damage, but it is generally believed that ELF-EMF is too weak to directly damage DNA. Nevertheless, a recent study shows that long-term occupational exposure to ELF-EMF may cause a genetically toxic effect. The researchers believe that DNA damage is caused by the magnetic field due to the oxidative stress that the magnetic field induced [32]. Another meta-analysis on the relation between ELF- EMF and the risk of cancer suggests that ELF-EMF increases the risk of cancer [33].

32. Bagheri Hosseinabadi M, Khanjani N, Mirzaii M, et al. DNA damage from long-term occupational exposure to extremely low frequency electromagnetic fields among power plant workers. Mutat Res, 2019,846:403079

33. Zhang Y, Lai J, Ruan G, et al. Meta-analysis of extremely low frequency electromagnetic fields and cancer risk: a pooled analysis of epidemiologic studies. Environ Int, 2016,88:36-43

MAGNETIC FIELD EFFECTS IN BIOLOGY FROM THE PERSPECTIVE OF THE RADICAL PAIR MECHANISM

Zadeh-Haghighi Hadi, Simon Christoph. Magnetic field effects in biology from the perspective of the radical pair mechanism. J. R. Soc. Interface. Aug 3, 2022. 192022032520220325. doi: 10.1098/rsif.2022.0325.

Abstract

Hundreds of studies have found that weak magnetic fields can significantly influence various biological systems. However, the underlying mechanisms behind these phenomena remain elusive. Remarkably, the magnetic energies implicated in these effects are much smaller than thermal energies. Here, we review these observations, and we suggest an explanation based on the radical pair mechanism, which involves the quantum dynamics of the electron and nuclear spins of transient radical molecules. While the radical pair mechanism has been studied in detail in the context of avian magnetoreception, the studies reviewed here show that magnetosensitivity is widespread throughout biology. We review magnetic field effects on various physiological functions, discussing static, hypomagnetic and oscillating magnetic fields, as well as isotope effects. We then review the radical pair mechanism as a potential unifying model for the described magnetic field effects, and we discuss plausible candidate molecules for the radical pairs. We review recent studies proposing that the radical pair mechanism provides explanations for isotope effects in xenon anaesthesia and lithium treatment of hyperactivity, magnetic field effects on the circadian clock, and hypomagnetic field effects on neurogenesis and microtubule assembly. We conclude by discussing future lines of investigation in this exciting new area of quantum biology.

Open access paper: https://royalsocietypublishing.org/doi/10.1098/rsif.2022.0325

MEASUREMENT AND ESTIMATION OF THE MAGNETIC FIELDS IN ELECTRIC VEHICLES

M. Garvanova, I. Garvanov, V. Ivanov, D. Borissova. 2022 22nd International Symposium on Electrical Apparatus and Technologies (SIELA), 2022, pp. 1-4, doi: 10.1109/SIELA54794.2022.9845773.

Abstract

To solve the problem of harmful emissions emitted by internal combustion vehicles such as carbon dioxide, nitrogen oxides, soot and others, the use of electric cars is proposed. These devices operate on electricity that induces “electromagnetic pollution” in or near them. The effects of electromagnetic fields on living organisms are undeniable, but it is not yet clear how harmful they are to humans. In electric car, passengers sit very close to an electrical system that operates at considerable power and for a long period of time. This means that consumers are exposed to artificial magnetic fields. Electric car manufacturers are very familiar with these problems and offer various technological solutions in their design and production. In the present article, experimental measurements of the magnetic fields generated by an electric car operating in different operating modes will be performed and recommendations for its proper operation will be given.

Excerpts

The levels of MF when driving in urban conditions are constantly changing in the range of about 100–200 nT. When starting and stopping, the levels are relatively high in the range of

170–230 nT. When the car is stopped at a traffic light, the level of the MF is in the range of 165–200 nT.

When driving the electric car on the highway at speeds of 50, 80 and 100 km/h, MF levels of the order of 100– 300 nT are obtained. The measurement results are shown in Table 2

The obtained results show that in the passenger compartment of a car operating in different operating modes, the MF levels are normal. This is achieved thanks to the engineering solutions used in the production of the electric car. It is noteworthy that when accelerating and stopping the car, relatively high values of MF are observed, but this is for very short periods of time. More worrying is the fact of prolonged exposure and relatively high values of MF at high speeds of the electric car. The power, weight, acceleration and speed of the car affect the power of the MF generated in the car body. When charging the electric car, it is recommended that people are outside the car and as far away from it as possible. The three factors that have the strongest impact on human health are: high levels of electromagnetic fields, small distances between the generators of these fields and passengers, as well as relatively long exposure. https://ieeexplore.ieee.org/document/9845773

COMPARISON OF EMF EXPOSURE LIMITS AND ASSESSMENT FOR ELECTRIC VEHICLE WIRELESS POWER TRANSFER

N. Li, Y. Wang, J. Zhang, Z. Gan. Comparison of EMF Exposure Limits and Assessment for Electric Vehicle Wireless Power Transfer. 2022 IEEE 5th International Electrical and Energy Conference (CIEEC), 2022, pp. 3944-3948, doi: 10.1109/CIEEC54735.2022.9846400.

Abstract

The electric and magnetic fields (EMF) generated by electric vehicle wireless power transfer might have health effects on the human inside and around the electric vehicle, including persons with active implantable medical devices. The comparative analysis on the EMF limits, measurement methods and assessment methods in the relevant EMF exposure standards were conducted, and the similarities and differences between domestic and foreign EMF standards and the international mainstream view were obtained. These provide the reference for the measurement and environmental impact assessment of electric vehicle wireless power transfer, as well as for revising Chinese national standard. The simulation and test research will be required with respect to the issues in the future, including assessment method of basic restrictions. https://ieeexplore.ieee.org/document/9846400

THE EFFECTS OF OPERATING FREQUENCY ON WIRELESS POWER TRANSFER SYSTEM DESIGN AND HUMAN HEALTH IN ELECTRIC VEHICLES

A. Ağçal, T. H. Doğan, G. Aksu. The effects of operating frequency on wireless power transfer system design and human health in electric vehicles. Electrica. 22(2): 188-197, 2022.

Abstract

Wireless power transfer (WPT) continues to be popular in today’s world because it is used in situations where the use of cables is difficult, dangerous, or restrictive. In WPT, electrical energy is transmitted over the air by magnetic connections instead of cables. In this paper, WPT system designs were made with 10 kHz and 20 kHz operating frequencies, 3.3 kW output power, and 50 cm × 50 cm size. The effects of the frequency on the WPT system were analyzed

with the designs made for two separate frequencies. The WPT circuits were established in the MATLAB/Simulink program. The coil design of the WPT systems was made in ANSYS® Maxwell 3D. The critical air gap values of the 10 kHz and 20 kHz designs were determined as 15 cm and 17 cm, respectively. In this study, the efficiency of the WPT system was obtained as 88.79% at 15 cm air gap for 10 kHz and 92.74% at 17 cm air gap for 20 kHz. Wireless power transfer systems in different frequency bands at the same power were compared in terms of efficiency, loss, cost, and electromagnetic field distribution. In addition, the effects of WPT systems on human health were examined according to IEEE and ICNIRP standards.

Excerpt

In which regions the magnetic field emitted by the coils is safe and unsafe for human health has been determined according to IEEE and ICNIRP standards. In this study, it has been observed that scattering can pose a danger to human health when one is between or very close to the receiver and transmitter coil. When one moves away from the coils as much as approximately the coil diameter, a safe area for public exposure is reached in 20 kHz systems. On the other hand, in 10 kHz systems, it is necessary to move further away from the boundaries of the 20 kHz system for a safe area. In this case, it is shown that WPT systems need living and object detection systems to shut down the system when a living being or an object is between or near the receiver and transmitter. In addition, it has been observed that the magnetic field created by the 20 kHz design is less than the 10 kHz design. High-frequency designs have lower inductance values, lower number of turns, and correspondingly lower magnetic flux density.

Open access paper: https://electricajournal.org/en/the-effects-of-operating-frequency-on-wireless-power- transfer-system-design-and-human-health-in-electric-vehicles-161797

DIFFERENTIAL BIOLOGICAL RESPONSES OF ADHERENT AND NON-ADHERENT (CANCER AND NON-CANCEROUS) CELLS TO VARIABLE EXTREMELY LOW FREQUENCY MAGNETIC FIELDS

Nezamtaheri MS, Goliaei B, Shariatpanahi SP, Ansari AM. Differential biological responses of adherent and non- adherent (cancer and non-cancerous) cells to variable extremely low frequency magnetic fields. Sci Rep. 2022 Aug 20;12(1):14225. doi: 10.1038/s41598-022-18210-y.

Abstract

Extremely low-frequency electromagnetic field (ELF-EMF) induces biological effects on different cells through various signaling pathways. To study the impact of the ELF-EMF on living cells under an optimal physiological condition, we have designed and constructed a novel system that eliminates several limitations of other ELF- EMF systems. Apoptosis and cell number were assessed by flow cytometry and the Trypan Blue dye exclusion method, respectively. In vitro cell survival was evaluated by colony formation assay. The distribution of cells in the cell cycle, intracellular ROS level, and autophagy were analyzed by flow cytometer. Suspended cell differentiation was assessed by phagocytosis of latex particles and NBT reduction assay. Our results showed that response to the exposure to ELF-EMF is specific and depends on the biological state of the cell. For DU145, HUVEC, and K562 cell lines the optimum results were obtained at the frequency of 0.01 Hz, while for MDA-MB- 231, the optimum response was obtained at 1 Hz. Long-term exposure to ELF-EMF in adherent cells effectively inhibited proliferation by arresting the cell population at the cell cycle G2/M phase

and increased intracellular ROS level, leading to morphological changes and cell death. The K562 cells exposed to the ELF-EMF differentiate via induction of autophagy and decreasing the cell number. Our novel ELF-EMF instrument could change morphological and cell behaviors, including proliferation, differentiation, and cell death.
Open access paper: https://www.nature.com/articles/s41598-022-18210-y

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MATERNAL STRESS INDUCED ANXIETY-LIKE BEHAVIOR EXACERBATED BY ELECTROMAGNETIC FIELDS RADIATION IN FEMALE RATS OFFSPRING

Hosseini E, Farid Habibi M, Babri S, Mohaddes G, Abkhezr H, Heydari H. Maternal stress induced anxiety-like behavior exacerbated by electromagnetic fields radiation in female rats offspring. PLoS One. 2022 Aug 23;17(8):e0273206. doi: 10.1371/journal.pone.0273206.

Abstract

There is a disagreement on whether extremely low frequency electromagnetic fields (ELF-EMF) have a beneficial or harmful effect on anxiety-like behavior. Prenatal stress induces frequent disturbances in offspring physiology such as anxiety-like behavior extending to adulthood. This study was designed to evaluate the effects of prenatal stress and ELF-EMF exposure before and during pregnancy on anxiety-like behavior and some anxiety-related pathways in the hippocampus of female rat offspring. A total of 24 female rats 40 days of age were distributed into four groups of 6 rats each: control, Stress (rats whose mothers underwent chronic stress), EMF (rats whose mothers were exposed to electromagnetic fields) and EMF/S (rats whose mothers were simultaneously exposed to chronic stress and ELF-EMF). The rats were given elevated plus-maze and open field tests and then their brains were dissected and their hippocampus were subjected to analysis. ELISA was used to measure 24(S)- hydroxy cholesterol, corticosterone, and serotonin levels. Cryptochrome2, steroidogenic acute regulatory protein, 3B-Hydroxy steroid dehydrogenase, N-methyl-D-aspartate receptor 2(NMDAr2) and phosphorylated N- methyl-D-aspartate receptor 2(PNMDAr2) were assayed by immunoblotting. Anxiety-like behavior increased in all treatment groups at the same time EMF increased anxiety induced by maternal stress in the EMF/S group.

The stress group showed decreased serotonin and increased corticosterone levels. ELF-EMF elevated the PNMDAr2/NMDAr2 ratio and 24(S)-hydroxy cholesterol compared to the control group but did not change corticosterone. EMF did not restore changes induced by stress in behavioral and molecular tests. The results of the current study, clarified that ELF-EMF can induce anxiety-like behavior which may be attributed to an increase in the PNMDAr2/NMDAr2 ratio and 24(S)-OHC in the hippocampus, and prenatal stress may contribute to anxiety via a decrease in serotonin and an increase in corticosterone in the hippocampus. We also found that anxiety-like behavior induced by maternal stress exposure is exacerbated by electromagnetic field radiation.

Open access paper:
https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0273206

CHRONIC BLUE LIGHT LEADS TO ACCELERATED AGING IN DROSOPHILA BY IMPAIRING ENERGY METABOLISM AND NEUROTRANSMITTER LEVELS

Jun Yang, Song Yujuan, Law Alexander D., Rogan Conno J., Shimoda Kelsey, Djukovic Danijel, Anderson Jeffrey C., Kretzschmar Doris, Hendrix David A., Giebultowicz Jadwiga M. Frontiers in Aging. Vol. 3, 2022, doi: 10.3389/fragi.2022.983373.

Abstract

Blue light (BL) is becoming increasingly prevalent in artificial illumination, raising concerns about its potential health hazard to humans. In fact, there is evidence suggesting that acute BL exposure may lead to oxidative stress and death of retinal cells specialized for photoreception. On the other hand, recent studies in Drosophila melanogaster demonstrated that chronic BL exposure across lifespan leads to accelerated aging manifested in reduced lifespan and brain neurodegeneration even in flies with genetically ablated eyes, suggesting that BL can damage cells and tissues not specialized for light perception. At the physiological level, BL exposure impairs mitochondria function in flies, but the metabolic underpinnings of these effects have not been studied. Here, we investigated effects of chronic BL on metabolic pathways in heads of eyes absent (eya²) mutant flies in order to focus on extra-retinal tissues. We compared metabolomic profiles in flies kept for 10 or 14 days in constant BL or constant darkness, using LC-MS and GC-MS. Data analysis revealed significant alterations in the levels of several metabolites suggesting that critical cellular pathways are impacted in BL-exposed flies. In particular, dramatic metabolic rearrangements are observed in heads of flies kept in BL for 14 days, including highly elevated levels of succinate but reduced levels of pyruvate and citrate, suggesting impairments in energy production. These flies also show onset of neurodegeneration and our analysis detected significantly reduced levels of several neurotransmitters including glutamate and Gamma-aminobutyric acid (GABA), suggesting that BL disrupts brain homeostasis. Taken together, these data provide novel insights into the mechanisms by which BL interferes with vital metabolic pathways that are conserved between fly and human cells.

Open access paper: https://www.frontiersin.org/articles/10.3389/fragi.2022.983373

GENETIC ANALYSIS OF CRYPTOCHROME IN INSECT MAGNETOSENSITIVITY

Kyriacou CP, Rosato E.Front Physiol. 2022 Aug 10;13:928416. doi: 10.3389/fphys.2022.928416.

Abstract

The earth's magnetic field plays an important role in the spectacular migrations and navigational abilities of many higher animals, particularly birds. However, these organisms are not amenable to genetic analysis, unlike the model fruitfly, Drosophila melanogaster, which can respond to magnetic fields under laboratory conditions. We therefore review the field of insect magnetosensitivity focusing on the role of the Cryptochromes (CRYs) that were first identified in Arabidopsis and Drosophila as key molecular components of circadian photo-entrainment pathways. Physico-chemical studies suggest that photo-activation of flavin adenine dinucleotide (FAD) bound to CRY generates a FADo- Trpo+ radical pair as electrons skip along a chain of specific Trp residues and that the quantum spin chemistry of these radicals is sensitive to magnetic fields. The manipulation of CRY in several insect species has been performed using gene editing, replacement/rescue and knockdown methods. The

effects of these various mutations on magnetosensitivity have revealed a number of surprises that are discussed in the light of recent developments from both in vivo and in vitro studies.
Open access paper: https://www.frontiersin.org/articles/10.3389/fphys.2022.928416/full

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HIGH-POWER ELECTROMAGNETIC PULSE EXPOSURE (EMP) OF HEALTHY MICE: EFFECTS ON COGNITION, NEURONAL ACTIVITY, AND HIPPOCAMPAL STRUCTURES

Hao Y, Liu W, Xu Z, Jin X, Ye Y, Yu C, Hu C, Zuo H, Li Y. High-Power Electromagnetic Pulse Exposure of Healthy Mice: Assessment of Effects on Mice Cognitions, Neuronal Activities, and Hippocampal Structures. Front Cell Neurosci. 2022 Jun 29;16:898164. doi: 10.3389/fncel.2022.898164.

Abstract

Electromagnetic pulse (EMP) is a high-energy pulse with an extremely rapid rise time and a broad bandwidth. The brain is a target organ sensitive to electromagnetic radiation (EMR), the biological effects and related mechanisms of EMPs on the brain remain unclear. The objectives of the study were to assess the effects of EMP exposure on mouse cognitions, and the neuronal calcium activities in vivo under different cases of real-time exposure and post exposure. EMP-treated animal model was established by exposing male adult C57BL/6N mice to 300 kV/m EMPs. First, the effects of EMPs on the cognitions, including the spatial learning and memory, avoidance learning and memory, novelty-seeking behavior, and anxiety, were assessed by multiple behavioral experiments. Then, the changes in the neuronal activities of the hippocampal CA1 area in vivo were detected by fiber photometry in both cases of during real-time EMP radiation and post-exposure. Finally, the structures of neurons in hippocampi were observed by optical microscope and transmission electron microscope. We found that EMPs under this condition caused a decline in the spatial learning and memory ability in mice, but no effects on the avoidance learning and memory, novelty-seeking behavior, and anxiety. The neuron activities of hippocampal CA1 were disturbed by EMP exposure, which were inhibited during EMP exposure, but activated immediately after exposure end. Additionally, the CA1 neuron activities, when mice entered the central area in an Open field (OF) test or explored the novelty in a Novel object exploration (NOE) test, were inhibited on day 1 and day 7 after radiation. Besides, damaged structures in hippocampal neurons were observed after EMP radiation. In conclusion, EMP radiation impaired the spatial learning and memory ability and disturbed the neuronal activities in hippocampal CA1 in mice.

Open access paper: https://www.frontiersin.org/articles/10.3389/fncel.2022.898164/ful

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EVIDENCE FOR A HEALTH RISK BY RF ON HUMANS LIVING AROUND MOBILE PHONE BASE STATIONS

Balmori, A. Evidence for a health risk by RF on humans living around mobile phone base stations: From radiofrequency sickness to cancer. Environmental Research (2022), doi: 10.1016/j.envres.2022.113851.

Abstract

The objective of this work was to perform a complete review of the existing scientific literature to update the knowledge on the effects of base station antennas on humans. Studies performed in real urban conditions, with mobile phone base stations situated close to apartments, were selected. Overall results of this review show three types of effects by base station antennas on the health of people: radiofrequency sickness (RS), cancer (C) and

changes in biochemical parameters (CBP). Considering all the studies reviewed globally (n=38), 73.6% (28/38) showed effects: 73.9% (17/23) for radiofrequency sickness, 76.9% (10/13) for cancer and 75.0% (6/8) for changes in biochemical parameters. Furthermore, studies that did not meet the strict conditions to be included in this review provided important supplementary evidence. The existence of similar effects from studies by different sources (but with RF [radio frequency radiation] of similar characteristics), such as radar, radio and television antennas, wireless smart meters and laboratory studies, reinforce the conclusions of this review. Of special importance are the studies performed on animals or trees near base station antennas that cannot be aware of their proximity and to which psychosomatic effects can never be attributed.

Excerpts

Introduction: During the last few decades, hundreds of thousands of mobile phone base stations and other types of wireless communications antennas have been installed around the world, in cities and in nature, including protected natural areas, in addition to pre-existing antennas (television, radio broadcasting, radar, etc.). Only the aesthetic aspects or urban regulations have been generally considered in this deployment, while the biological, environmental and health impacts of the associated non-ionizing electromagnetic radiation emissions have not been assessed so far. Therefore, the effects on humans living around these anthropogenic electromagnetic field sources (antennas) have not been considered.

In France, there is a significant contribution of mobile phone base stations in the exposure to radiofrequency electromagnetic fields (RF-EMF) of urban citizens living nearby (De Giudici et al., 2021). Some studies from India indicate that more than 15% of people have levels of EMF strength above 12 V/m due to their proximity to antennas (Premlal and Eldhose, 2017). Exposure estimates have shown that RF-EMF from mobile telephone systems is stronger in urban than in rural areas. For instance, in Sweden the levels of RF radiation have increased considerably in recent years, both outdoor and indoor, due to new telecommunication technologies, and the median power density measured for RF fields between 30 MHz and 3 GHz was 16 μW/m2 in rural areas, 270 μW/m2 in urban areas and 2400 μW/m2 in city areas (Hardell et al., 2018). Total exposure varies not only between urban and rural areas but also, depending on residential characteristics, between different floors of a building, with a tendency for building exposure to increase at higher floors (Breckenkamp et al., 2012).

Over the past five decades, and more intensively since the beginning of this century, many studies and several reviews have been published on the effects of anthropogenic electromagnetic radiation on humans living around the antennas. The first studies were carried out with radio and television antennas, investigating increases in cancer and leukaemia (Milham, 1988; Maskarinec et al., 1994; Hocking et al., 1996; Dolk et al., 1997a, 1997b; Michelozzi et al., 1998; Altpeter et al., 2000), as well as around radars (Kolodynski and Kolodynska, 1996; Goldsmith, 1997).

Regarding base station antennas, there are scientific discrepancies in their effects: some studies concluded that there are no health-related effects (e.g. Augner and Hacker, 2009; Blettner et al., 2009; Röösli et al., 2010; Baliatsas et al., 2016) whereas others found increases in cancer and other health problems in humans living around antennas (e.g. Santini et al., 2002; Navarro et al., 2003; Bortkiewicz et al., 2004; Eger et al., 2004; Wolf and Wolf, 2004;

Abdel-Rassoul et al., 2007; Khurana et al., 2010; Dode et al., 2011; Shinjyo and Shinjyo, 2014; Gandhi et al., 2015; López et al., 2021; Rodrigues et al., 2021). There is a specific symptomatology linked to radar and RF exposure at low levels, characterized by functional disturbances of the central nervous system (headache, sleep disturbance, discomfort, irritability, depression, memory loss, dizziness, fatigue, nausea, appetite loss, difficulty in concentration, dizziness, etc.), that has been termed 'RF sickness' (Lilienfeld et al., 1978; Johnson Lyakouris, 1998; Navarro et al., 2003).

Methods: Only studies performed in real urban conditions, with mobile phone base stations situated close to apartments, were selected. Studies conducted in larger regions with numerous antennas, based on surveys and geographic data, were also included.

Results: The studies that met the selected criteria are presented in chronological order in Table 1, catalogued as Y/N depending on whether or not they found effects. The selected studies cover three types of effects: radiofrequency sickness (RS) (according to Lilienfeld et al., 1978; Johnson Lyakouris, 1998), cancer (C) and changes in biochemical parameters (CBP). Table 1 also includes the authors, year and country, antenna type, study design, diseases and symptoms found/not found and the main conclusions of each study.

Discussion: Considering all the selected studies (n=38), 73.6% (28/38) showed effects: 73.9% (17/23) for radiofrequency sickness, 76.9% (10/13) for cancer and 75.0% (6/8) for changes in biochemical parameters (Figure 1). Therefore, most of the studies carried by research groups from twenty different countries reach the same conclusions.

For the reasons previously explained, the following studies (n=85) were not considered in this review, even though the conclusions of some of these studies will be discussed later due to their importance regarding the similarities of the electromagnetic radiation types involved and the effects found in many cases....

The results of this review show three types of effects by base station antennas on the health of humans: radiofrequency sickness, cancer and changes in biochemical parameters (Fig. 1). From among all these studies, most of them found effects (73.6%). Thus, despite some limitations and differences in study design, statistical measures, risk estimates and exposure categories (Khurana et al., 2010), together they provide a consistent view of the effects on the health of people living in the vicinity of base station antennas.

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) is a private organization that issues exposure guidelines that are then adopted by governments, but it has been accused of having conflicts of interest (Hardell and Carlberg, 2020; Hardell et al., 2021). The ICNIRP (2010, 2020) limits are thousands of times above the levels where effects are recorded for both extremely low frequency and RF man-made EMF and account only for thermal effects, whereas the vast majority of recorded effects are non-thermal. These existing guidelines for public health protection only consider the effects of acute intense (thermal) exposures and do not protect from lower level long-term exposures (Israel et al., 2011; Yakimenko et al., 2011; Blank et al., 2015; Starkey, 2016; Belpomme and Irigaray, 2022). The exposure duration is crucial to assess the induced effects.

Conclusion: In the current circumstances, it seems that the scientific experts in the field are very clear about the serious problems we are facing and have expressed this through important appeals (Blank et al., 2015; Hardell and Nyberg, 2020). However, the media, the responsible organizations (World Health Organization, 2015) and the governments are not transmitting this crucial information to the population, who remain uninformed. For these reasons, the current situation will probably end in a crisis not only for health but also for the technology itself, as it is unsustainable and harmful to the environment and the people.
https://www.sciencedirect.com/science/article/abs/pii/S0013935122011781

IMMUNOTOXICITY OF RADIOFREQUENCY RADIATION (REVIEW)

Himanshi Yadav, Radhey Shyam Sharma, Rajeev Singh. Immunotoxicity of radiofrequency radiation. Environmental Pollution. 2022. doi: 10.1016/j.envpol.2022.119793.

Highlights

- Drastic growth in communication technologies increased RFR exposure in environment
- Recent evidences show close relation among radiation sensitivity and immune effects
- An intracellular signaling cascade responsible for RFR action on immune system is suggested
- A better understanding of RFR linked cell effects might help radiation protection
- Urgent need to recognize probable hazards of using RFR emitting devices in excess

Abstract

Growing evidence recommends that radiofrequency radiations might be a new type of environmental pollutant. The consequences of RFR on the human immune system have gained considerable interest in recent years, not only to examine probable negative effects on health but also to understand if RFR can modulate the immune response positively. Although several studies have been published on the immune effects of RFR but no satisfactory agreement has been reached. Hence this review aims to evaluate the RFR modulating impacts on particular immune cells contributing to various innate or adaptive immune responses. In view of existing pieces of evidence, we have suggested an intracellular signaling cascade responsible for RFR action. The bio-effects of RFR on immune cell morphology, viability, proliferation, genome integrity, and immune functions such as ROS, cytokine secretion, phagocytosis, apoptosis, etc. are discussed. The majority of existing evidence point toward the possible shifts in the activity, number, and/or function of immunocompetent cells, but the outcome of several studies is still contradictory and needs further studies to reach a conclusion. Also, the direct association of experimental studies to human risks might not be helpful as exposure parameters vary in real life. On the basis of recent available literature, we suggest that special experiments should be designed to test each particular signal utilized in communication technologies to rule out the hypothesis that longer exposure to RFR emitting devices would affect the immunity by inducing genotoxic effects in human immune cells.

Concluding remarks

I.Till date, the bulk of available research articles remarkably indicated the RFR-induced changes in innate and adaptive immune responses. The morphological and physiological modulations in the immune cells were reported such as variation in viability, gene and protein

expression, generation of ROS, induction of DNA damage, stimulation of inflammatory markers, altered normal immune functions and eventually provoking inflammatory reactions, chronic allergic reactions, autoimmune responses leading to damaged tissues and organs.

II.The oxidative stress via causing free radical damage to DNA appears to be the main mechanism for RFR action.

III.Many RFR studies showed conflicting conclusions because of the scarcity of subjects, variations in distance from the radiation source, exposure time, RFR frequency, mode of modulation, SAR, or power density used in various studies. Furthermore, studies even with the same experimental design showed varied responses in different types of cells.

IV.On the other hand, the findings from in vitro and in vivo studies on RFR should not be directly linked to human mobile phone usage as the duration and level of exposure to radiofrequency radiation were much higher in experimental studies as compared to what people experience with even high cell phone usage.

V.Collectively, in view of discussed limitations, the available research studies might not be enough to understand the RFR effect on the immune system.

VI.Since, the controversies exist in the recent literature on the effects of RFR on immune cell physiology, substantially more coordinated and detailed studies are needed to set up a definitive trend in RFR effects on immune cells. Such studies are also required to address the important issues of safety for the usage of technologies like cell phones and wireless equipment that are used increasingly in our everyday lives and to revise the current EMF public safety limits. https://pubmed.ncbi.nlm.nih.gov/35863710/

USE OF MOBILE PHONES AND PROGRESSION OF GLIOMA INCIDENCE SINCE 1979

My notes: Although the title of this IARC report is in German, the report is available in English. The report's summary, "no indications of a detectable effect of mobile phones have been found," seems misleading because it is inconsistent with the report's final conclusion, namely "An increased risk in the 10% heaviest mobile phone users was an exception to this general situation, as it remained plausible."

The report's bottom line: "This ecological data is not sufficient to dismiss every potential mobile phone related risk scenario, but suggests that the risk – if it exists - would be very small, only occur after very long latency periods of several decades, or only affect small subgroups within glioma patients."

If only a portion of the population has a genetic susceptibility to brain cancer in the presence of microwave radiation as appears to be the case with thyroid cancer (Luo et al., 2020), that could explain why the odds ratios obtained for brain cancer risk from case-control studies of heavy, long-term mobile phone users over- predict glioma incidence in the overall population based upon tumor registry data.

* Luo J, Li H, Deziel NC, Huang H, Zhao N, Ma S, Nie X, Udelsman R, Zhang Y. Genetic susceptibility may modify the association between cell phone use and thyroid cancer: A

population-based case-control study in Connecticut. Environmental Research. 2020 Mar;182:109013. doi: 10.1016/j.envres.2019.109013. Deltour I, Schuz J. Nutzung von Mobiltelefonen und Verlauf der Gliom-Inzidenz seit 1979: Vorhaben 3618S00000 (FM 8867). International Agency for Research on Cancer. Jun 2022.

Summary

1.1 Introduction

In the Nordic countries, the sharp increase in the use of mobile phone occurred in the mid-1990s among adults; thus, time trends in glioma incidence rates (IR) may provide information about possible risks associated with mobile phone use. We investigated time trends in IR of glioma, and compared IR and observed number of cases to those that would be expected under a range of hypothetical mobile phone risk scenarios, encompassing risk levels reported in published case-control studies.

1.2 Methods

We analyzed age standardised IR of glioma in Denmark, Finland, Norway, and Sweden among adults 20-84 years old, using data from national cancer registries and population data covering the period 1979-2016, using a log linear joinpoint analysis. Exposure distribution of use and of high level of use were obtained from self-reported information in the Nordic Interphone, the Cosmos-Denmark and the Cosmos-France datasets. Based on analytical epidemiological studies, we considered various scenarios according to which mobile phone use would hypothetically increase the glioma risk. We quantified compatibility, or absence of compatibility between the observed data and the risk scenarios by projecting incidence rates of glioma of men aged 40-69 years old under these scenarios and comparing them with the observed incidence rates in the Nordic countries.

1.3 Results

Glioma IR increased regularly with annual percent change (APC) of 0.6 (95% confidence interval (CI) 0.4-0.7) in men and 0.3 (95%CI 0.2-0.5) in women in the period 1979-2016. There were hardly any changes in IR among men and women below age 59. In men and women in their sixties, IR increased by 0.6 (95%CI 0.4-0.9) in men and 0.4 (95%CI 0.2-0.7) in women, regularly for the whole period of observation, while IR among 70-84 years old increased very markedly, with APC of 3.1 (95%CI 2.6-3.5) among men and 2.8 (95%CI 2.3-3.3) among women over at least the last 2 decades of observation. Very few risk scenarios appeared compatible with the observed data using standardised incidence ratios analyses. The risk scenarios that appeared compatible involved either long latencies (20 years), or very low risks (RR = 1.08); in these projections, risks that would be limited to mobile phone heavy users were not compatible with the observed number of cases.

1.4 Discussion

IR time trends did not demonstrate breakpoints in their secular evolution in the last 20 years. Virtually all the reported results from the case-control studies with a positive association between mobile phone use and glioma risk were shown to be implausible in our simulations comparing them with the observed incidence rates, implying that biases and errors have likely distorted their findings; very low risks at the population level, and risks after very long latencies remained plausible. Simulations were based on high quality case registration,

which is a strength, while the uncertainties in the exposure information and the limited information about some of the model's assumptions were limitations. Altogether, this study confirms and reinforces conclusions made previously, that no indications of a detectable effect of mobile phones have been found.

Excerpts

We analyzed the time trends in the incidence rates of glioma among adults aged 20 to 84 years of the Nordic countries from 1979 to 2016 (step 1 of the work description). Then, we addressed the question whether the observed time trends and observed number of cases were statistically different from the one we would observe if we assumed that the use of mobile phones caused glioma, so if we assumed that there was a true causal association (step 2 and step 3 of the work description). Within this, we delineated the levels of risks and the duration of induction periods that would not be compatible with the observed time trends and numbers of cases in this population (step 3 of the work description). We also discussed these findings in light of some of the elevated OR found in the literature. The study tested the consistency between risks that have been reported and the effect they would have had at the level of the population, had they been true. Noteworthy, the study was not meant to dismiss every single hypothetical association, as it would most likely always be possible to devise a pattern of risk that would fit the data....

This study was based on 28,015 male and 20,630 female glioma cases diagnosed from 1979 to 2016 in Denmark, Finland, Norway and Sweden (called "the Nordic countries" in the following). In 2016, the number of glioma cases was 1,724 in a population of 19.7 million adults aged 20–84 years. Over the last 10 years of data, Sweden accounted for 38% of the population and of the cases; of the remainder, Denmark, Finland, and Norway had populations of similar size. The age-standardized incidence rates were higher in men (9.1 per 100000 person years) than in women (6.1 per 100 000 person years), and higher with increasing age. All countries had comparable rates; Norway had slightly higher rates, while Finland had slightly lower rates in both sexes (Table 2 and Table 3).

Joinpoint analyses described in paragraph 6.1 showed that overall, the trends were smooth: glioma rates increased by 0.6% (95% CI 0.4%-0.7%) per year in men and 0.3% (95% CI 0.2%-0.5%) per year in women over the period 1979-2016 in the Nordic countries combined (Table 4 and Table 5), and in each country separately except for a marked increase in 1979-1984 in Swedish men (APC about 6%). For the younger age groups (20-39 and 40- 59 years old), the time trends were smooth and did not demonstrate strong increases at any point in time during the period 1979 to 2016 in any country among men (Table 6), and women (Table 7). Below the age of 60, incidence rates were generally stable over the whole period (Figure 1, Table 6 and Table 7). Among people aged 60-69 years old, incidence rates increased gradually by 0.6% in men and 0.4% in women per year, and these regular increases with no joinpoint were observed in every country and at a very similar rate in both sexes, except among Swedish women, whose rates showed a slight decrease. Irregular patterns were observed among the persons aged 70-84 years old at the beginning of the observation period, while for at least the last 12 years of observation, all countries showed highly increasing rates. Exceptions to this general pattern were noted among the Finnish males and the Norwegian females, in which an increase was seen at the beginning of the observation period that lasted at least 21 years.

The analysis by subgroups of tumour types could be performed only for the period 1990-2016 for reasons of data availability: in Sweden, a separate code for glioblastoma did not exist prior to 1993, and very few of the tumours which had been diagnosed during the period 1990-1992 were retrospectively coded into this code. Indeed, cancer registries are continuously updated when additional information becomes available on an earlier diagnosis, for example.

Among men and women, the rates of glioblastomas increased in the last years of observations, while the rate of other high-grade gliomas decreased (Table 8 and Table 9). Rates of low grade gliomas were relatively stable in all countries since the mid 1990's except in Denmark, where substantial increases were noted towards the end of the period of observation, albeit non-significant....

When examining the trends by subtypes, glioblastoma generally increased while other high grade gliomas decreased, and low grade glioma were stable in the most recent period, except in Denmark where low grade glioma rates increased among men and women in the last 3 years of observation. In Sweden, the rates of glioblastoma underwent most changes, namely the increase in glioblastoma rates in Sweden in the years after the introduction of that code by the cancer registry, since a new code is not mandatorily fully used immediately after it is introduced....

To sum up, our simplified and more sophisticated analyses appeared to indicate that the small increase in IR of men age 40-59 and the marked increase in RR of men aged 60-69 were generally not compatible with the same mobile phone related risks increases. When models in which the totality of the IR increases were assumed to be associated with mobile phone effects, a RR of 1.31 that would start 20 years after first using a mobile phone was borderline compatible between these 2 age groups, while all other induction periods (0, 5, 10, 15 years) or heavy users risk scenarios produced RR estimates and CI which did not overlap between the 2 age groups when the same exposure distribution was considered. When half of the IR increases were attributed to other factors, none of the mobile phone related risks scenarios were compatible with the data, in the SIR analyses (assuming the same risk in both age groups). When most (75%) of the IR increases were attributed to other factors, then small excess risks (RR= 1.08 applying to all users after 10 years) or risks after long latencies (RR = 1.3 applying to all users after 20 years) were compatible with the observed incidence rates and exposure distributions that we assumed. Further work on these scenarios could shed more light on the remaining uncertainties. Of note, scenarios of risks limited to heavy users groups did not appear compatible with the observed number of cases in these analyses....

Our simulation study is not free of assumptions. The induction period relating mobile phone use and glioma risk, if such an association exists, is unknown, so is the magnitude of the risk, and the real patterns may be more complex than the scenarios that we simulated. In addition, there are several factors that we did not account for. The coverage of the Nordic cancer registries was not complete, but some 1.5% to 10% of the malignant tumours were missed in this age group. In Sweden, it has been estimated that completeness would not have changed over the period 1998-2014, while completeness might have improved in other countries. We modelled that other, yet to be discovered, risk factors of the disease as well as improvement in its detection and reporting had a smooth, gradual impact, over the period 1979–2016,

which is consistent with the gradually increasing IR. We used 3 sources of information on the use of mobile phones, all self-reported, to evaluate the prevalence of use and heavy use up to 2002, 2008 or 2016 and extrapolated the prevalences for the periods and age groups for

which no data was available, based on the trends observed in the other age groups. The use of hands-free devices was not accounted for, although this was not frequent in these populations (data not shown).

In conclusion, it is difficult to demonstrate the absence of risk, in real life condition, and assumptions about the impact of the improvement of diagnosis tools, treatment and registration changes over time were used in our simulations. However, based both on the observed IR and the simulations, we reiterate and strengthen our previous conclusion that, the risk, should one exist, ought to be lower or occur after a longer induction period or act on a smaller population, or a combination of these, than most of the level of risk that have been reported in previously published case-control studies.

Conclusions

In this project we projected incidence rates of glioma under various scenarios of mobile phone-associated increased glioma risks, and compared them with the observed incidence rates in the Nordic countries. The comparison was carried out on the data of men aged 40 to 69 years. The modelled scenarios included risk increases reported from analytical epidemiological studies, which were all of case-control design. Most of those results were shown to be implausible in our simulations, implying that biases and errors in the self-reported use of mobile phones have likely distorted their findings. An increased risk in the 10% heaviest mobile phone users was an exception to this general situation, as it remained plausible. Results of cohort studies showing no association were compatible with observed incidence rates. We also studied what hypothetical mobile phone- related risks were conceivable if the changes in incidence rates in 40-59 year old and 60-69 year old men were fully attributable to mobile phone use. The fact that we observed different hypothetical risks in these two age groups while research at present has not suggested that older men should have higher risk related to mobile phone use than younger men, does not align with the assumption that mobile phone exposures caused the incidence rate trends. This ecological data is not sufficient to dismiss every potential mobile phone related risk scenario, but suggests that the risk – if it exists - would be very small, only occur after very long latency periods of several decades, or only affect small subgroups within glioma patients.

Open access report:
https://doris.bfs.de/jspui/bitstream/urn:nbn:de:0221202206303322 2/4/BfS_2022_3618S00000.pdf

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IMPROVEMENT OF SEVERAL STRESS RESPONSE AND SLEEP QUALITY HORMONES IN MEN AND WOMEN AFTER SLEEPING IN A BED THAT PROTECTS AGAINST ELECTROMAGNETIC FIELDS

Díaz-Del Cerro E, Félix J, Tresguerres J, De la Fuente M. Improvement of several stress response and sleep quality hormones in men and women after sleeping in a bed that protects against electromagnetic fields. Environ Health. 2022 Jul 22;21(1):72. doi: 10.1186/s12940-022-00882-8.

Abstract

Background: The electromagnetic fields (EMFs) emitted by the technologies affect the homeostatic systems (nervous, endocrine, and immune systems) and consequently the health. In a previous work, we observed that men and women, after 2 months of using a bed with a registered HOGO system, that prevents and drain EMFs, improved their immunity, redox and inflammatory states and rejuvenated their rate of aging or biological age. Since, EMFs can act as a chronic stressor stimulus, and affect the sleep quality. The objective of this work was to study in men and women (23-73 years old) the effect of sleeping for 2 months on that bed in the blood concentrations of several hormones related to stress response and sleep quality as well as to corroborate the rejuvenation of their biological age.

Methods: In 18 men and women, plasma concentration of cortisol, dehydroepiandrosterone (DHEA), catecholamines (epinephrine, norepinephrine and dopamine), serotonin, oxytocin and melatonin were analyzed before and after 2 months of using the HOGO beds. A group of 10 people was used as placebo control. In another cohort of 25 men (20 experimental and 5 placebo), the effects of rest on the HOGO system on the concentration of cortisol and testosterone in plasma were studied. In all these volunteers, the biological age was analyzed using the Immunity Clock model.

Results: There is a significant increase in plasma concentration of DHEA, norepinephrine, serotonin, oxytocin, and melatonin as well as in testosterone, after resting for 2 months in that bed with the EMFs avoiding system. In addition, decreases in Cortisol/DHEA and Testosterone/cortisol ratio and plasma dopamine concentration were observed. No differences were found in placebo groups. In all participants that slept on HOGO beds, the biological age was reduced.

Conclusions: Sleeping in a bed that isolates from EMFs and drain them can be a possible strategy to improve the secretion of hormones related to a better response to stress and sleep quality, which means a better endocrine system, and consequently better homeostasis and maintenance of health. This fact was confirmed with the slowdown in the rate of aging checked with a rejuvenation of the biological age.

Open access paper: https://ehjournal.biomedcentral.com/articles/10.1186/s12940-022-00882-8

EMPIRICAL STUDY OF THE STOCHASTIC NATURE OF ELECTROMAGNETIC FIELD EXPOSURE IN MASSIVE MIMO SYSTEMS (5G)

F. Héliot, T. H. Loh, D. Cheadle, Y. Gui, M. Dieudonne. An Empirical Study of the Stochastic Nature of Electromagnetic Field Exposure in Massive MIMO Systems. IEEE Access, vol. 10, pp. 63100-63112, 2022, doi: 10.1109/ACCESS.2022.3182236.

Abstract

Base stations (BSs) rely on the massive multiple-input multiple-output (mMIMO) technology in the fifth generation of mobile networks (5G). A technology having a major impact on the nature of the electromagnetic field (EMF) exposure in such systems. This work has used a fully reconfigurable mMIMO testbed (operating at 2.63 GHz), capable of mimicking realistic 5G new radio (NR) BS beamforming performance, to first gather experimental-based evidence of 5G BS EMF exposure within a real-world outdoor environment, to then analyze its stochastic behaviour, and to finally understand its impact on the definition of exclusion boundaries for 5G BSs. The exposure data of our testbed have been complemented by exposure data collected from a typical commercial 5G BS (operating at 3.65 GHz) to confirm the result trends and findings of our analysis. A robust metrology has been followed to obtain all the EMF exposure data. Our data and analysis indicate that significant exposure variations can be noticed according to the beam directions, i.e. the relative position of the exposure measurement location to the beam directions as well as the environment, confirming the stochastic nature of 5G BS exposure. The variance of the exposure tends to decrease as the number of users increase for a constant traffic load. Whereas the exposure grows sub-linearly with the traffic load, regardless of the number of users. As far as the exclusion boundary of 5G BS is concerned, its revised definition based on 95-th percentile seems still not flexible enough to accommodate the deployment of 5G BS in countries/places with stringent EMF exposure limits, as for instance in Belgium.

Conclusion

This paper has studied the stochastic nature of the EMF exposure and how it can impact the de finition of the exclusion boundary, especially under the constraint of stringent exposure limits, by relying on two different approaches for gathering experimental-based evidences. First we have used a fully reconfi gurable mMIMO testbed for evaluating the spatial and temporal variations of the RF-EMF exposure in a controlled outdoor scenario. Then, we have used a typical commercial 5G BS to complement/confirm some of the results/trends obtained via the mMIMO testbed. Several important insights can be inferred from our measurement campaign results:

- EMF exposure due to 5G BS grows linearly with the number of utilized RF chains at the BS.

- Significant exposure variations can result from the beam directionality, i.e. the relative position of the exposure measurement location to the beam direction has a significant impact on the measured exposure. This suggests a very dynamic/changing exposure environment driven by active UEs in 5G, in clear contrast with previous cellular technologies.

- Environmental effects, such as indirect propagation paths (e.g. re flecting off objects) or blocked paths can also create further variations.

- The variance of the exposure tends to decrease as the number of active UEs increases when the traffic remains constant, or in other words it becomes more deterministic. Whereas the exposure grows sub-linearly with the traffi c, regardless of the number of active UEs.

- The statistical distribution of EMF exposure for 5G BSs should be better understood and probably taken into account for defi ning the exclusion boundary. The results of our two measurement campaigns indicate that the statistics of different 5G BSs are not necessarily the same, i.e., the exposure of our mMIMO testbed BS follows a Poisson distribution while the commercial 5G BS exposure is closer to a normal distribution. In turn, this can impact the exclusion boundary size when it is defi ned as a particular percentile of the exposure cdf.

- Defining the BS exclusion boundary based on the 95-th percentile seems to not be a exible enough approach to accommodate the deployment of 5G BS in countries/places with stringent EMF exposure limits. Our measurement results correspond to a boundary size in the order of several tens of meters for an exposure limit of 6 V/m based on the 95-th percentile. The quality and quantity of field strength data collection need to be carefully considered to properly tune the extrapolation parameters in the SSB method as well as to accurately model the EMF exposure distribution of a particular 5G BS site.

- In the future, we would like to extend this work to mm-wave frequencies and build an empirical statistical model of the EMF exposure based on the same metrology approach.

https://ieeexplore.ieee.org/document/9794655

COMPUTATIONAL ASSESSMENT OF RF EXPOSURE LEVELS DUE TO 5G MOBILE PHONES

M. Bonato et al. Computational Assessment of RF Exposure Levels due to 5G Mobile Phones. 2022 Microwave Mediterranean Symposium (MMS), 2022, pp. 1-4, doi: 10.1109/MMS55062.2022.9825603.

Abstract

The present work was performed to expand the knowledge on human RF-EMF exposure, considering the use of mm-wave spectrum in mobile communication applications, due to the deployment of 5th generation (5G) networks. The mobile antenna was modelled based on the 5G innovation technologies (i.e., mm-Wave bands, beamforming capability and high gain), resulting in a phased array antenna with 8 elements at the working frequency of 27 GHz. Three different skin layers models were simulated, to spot differences in the peaks of absorbed power density averaged over 4 cm2, following the ICNIRP guidelines. The simulations were implemented using the Sim4Life platform, simulating not only the presence of a mobile phone user, but also of a person passing nearby, who could be hit by the phased array antenna main beam. This work underlined that the absorbed power density peaks were greatly underestimated using the homogeneous skin model, respect to the multi-layers skin

models. Moreover, for the person passing nearby, we found slightly higher exposure levels than those assessed for the mobile phone user. Lastly, in all the examined cases, the limits indicated by the ICNIRP guidelines were well respected.

Excerpt
These findings are also confirmed evaluating the three different configurations for the other two multi-layers models and analyzing the peak values of Sab in the most superficial tissue (i.e., the dermis in the homogeneous model and the stratum corneum in the two multi-layers models). Indeed, as we can see from Fig. 3, where the peak values of Sab are illustrated, the highest exposure levels are obtained for the person passing nearby. The highest peak value for the person passing nearby is obtained for the three-layers skin model, in the configuration where both the user and the person nearby are considered, with values equal to 6.97 W/m2 > whereas the highest peak value for the user is obtained in the same configuration, but for the four-layers model, with value equal to 5.80 W/m2.

Interestingly, the results showed that the use of a homogenous skin model could led to underestimate the exposure peak levels from 18% to 55% respect to the use of multi-layer models. This is probably due to the multiple reflections of the mm-waves that occur at the boundaries of the different tissue layers, and it is in line with other literature studies, where it was underlined the need to use multi-layers models for assessing the exposure levels when the mm-wave spectrum is considered [13], [16].

Lastly, all the peak values obtained greatly respected the basic restrictions of 20 W/m2, indicated in the ICNIRP guidelines [7]. https://ieeexplore.ieee.org/document/9825603

A META-ANALYSIS OF THE RISK OF SALIVARY GLAND TUMORS ASSOCIATED WITH MOBILE PHONE USE: THE IMPORTANCE OF CORRECT EXPOSURE ASSESSMENT

Vijayan K, Eslick GD. A meta-analysis of the risk of salivary gland tumors associated with mobile phone use: the importance of correct exposure assessment. Rev Environ Health. 2022 Jul 11. doi: 10.1515/reveh-2022-0055.

Abstract
Objectives: To investigate the risk of developing salivary gland tumors associated with the use of mobile phones.

Content: There have been a number of epidemiological studies conducted to assess for a possible association between mobile phone usage and the development of intracranial tumours, however results have been conflicting. We conducted an extensive literature search across four different databases. After selecting the articles relevant to the area of study, a total of seven studies were included in this meta-analysis, with no restrictions set on publication date or language. Studies were qualitatively assessed using the Newcastle-Ottawa scale. No significant association between the use of mobile phones and salivary gland tumors was observed (OR=1.06, 95% CI=0.86-1.32). No evidence for publication bias was detected.

Summary and outlook: Our findings indicate no significant association between mobile phone usage and salivary gland tumours. However, there were many limitations encountered in these studies, suggesting that the observed result may not be an accurate estimate of the

true carcinogenic risk of mobile phones, especially for heavy long-term users. In fact, the studies included in this meta-analysis highlight the need to correctly define exposure assessment in order to ascertain the risk of a certain variable. https://pubmed.ncbi.nlm.nih.gov/35822706/

IDIOGRAPHIC APPROACH TO IDIOPATHIC ENVIRONMENTAL INTOLERANCE ATTRIBUTED TO ELECTROMAGNETIC FIELDS (IEI-EMF) PART I. ENVIRONMENTAL, PSYCHOSOCIAL & CLINICAL ASSESSMENT OF 3 INDIVIDUALS WITH SEVERE IEI-EMF

Dömötör Z, Szabolcs Z, Bérdi M, Witthöft M, Köteles F, Szemerszky R. An idiographic approach to idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF) part I. Environmental, psychosocial and clinical assessment of three individuals with severe IEI-EMF. Heliyon. 2022 Jul 16;8(7):e09987. doi: 10.1016/j.heliyon.2022.e09987.

Abstract

IEI-EMF refers to an environmental illness whose primary feature is the occurrence of symptoms that are attributed to exposure to weak electromagnetic fields (EMFs). There is a growing evidence that this condition is characterized by marked individual differences thus a within-subject approach might add important information beyond the widely used nomothetic method. A mixed qualitative/quantitative idiographic protocol with a threefold diagnostic approach was tested with the participation of three individuals with severe IEI-EMF. In this qualitative paper, the environmental, psychosocial, and clinical aspects are presented and discussed (results of ecological momentary assessment are discussed in Part II of this study). For two participants, psychopathological factors appeared to be strongly related to the condition. Psychological assessment indicated a severe pre- psychotic state with paranoid tendencies, supplemented with a strong attentional focus on bodily sensations and health status. The psychological profile of the third individual showed no obvious pathology. Overall, the findings suggest that the condition might have uniformly been triggered by serious psychosocial stress for all participants. Substantial aetiological differences among participants with severe IEI-EMF were revealed. The substantial heterogeneity in the psychological and psychopathological profiles associated with IEI-EMF warrants the use of idiographic multimodal assessments in order to better understand the different ways of aetiology and to facilitate person-taylored treatments.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9305360/

SHORT-TERM EXPOSURE TO RADIOFREQUENCY RADIATION AND METABOLIC ENZYMES' ACTIVITIES DURING PREGNANCY AND PRENATAL DEVELOPMENT

Tomruk A, Ozgur-Buyukatalay E, Ozturk GG, Ulusu NN. Short-term exposure to radiofrequency radiation and metabolic enzymes' activities during pregnancy and prenatal development. Electromagn Biol Med. 2022 Jul 29:1-9. doi: 10.1080/15368378.2022.2104309.

Abstract

Radiofrequency radiation (RFR) as an environmental and physical pollutant may induce vulnerability to toxicity and disturb fetal development. Therefore, the potential health effects of short-term mobile phone like RFR exposure (GSM 1800 MHz; 14 V/m, 2 mW/kg specific absorption rate (SAR) during 15 min/day for a week) during pregnancy and also the development of fetuses were investigated. Hepatic glucose regulation and glutathione-dependent enzymes' capacities were biochemically analyzed in adult (female) and pregnant

New Zealand White rabbits. Pregnant rabbits' two-day-old offspring were included to understand their developmental stages under short-term maternal RFR exposure. We analyzed two regulatory enzymes in the oxidative phase of phosphogluconate pathways to interpret the cytosolic NADPH's biosynthesis for maintaining mitochondrial energy metabolism. Moreover, the efficiencies of maternal glutathione-dependent enzymes on both the removal of metabolic disturbances during pregnancy and fetus development were examined. Whole- body RFR exposures were applied to pregnant animals from the 15th to the 22nd day of their gestations, i.e., the maturation periods of tissues and organs for rabbit fetuses. There were significant differences in hepatic glucose regulation and GSH-dependent enzymes' capacities with pregnancy and short-term RFR exposure. Consequently, we observed that intrauterine exposure to RFR might lead to cellular ROS- dependent disturbances in metabolic activity and any deficiency in the intracellular antioxidant (ROS-scavenging) system. This study might be a novel insight into further studies on the possible effects of short-term RF exposure and prenatal development. https://pubmed.ncbi.nlm.nih.gov/35904122/

IMMUNE RESPONSES TO MULTI-FREQUENCIES OF 1.5 GHZ AND 4.3 GHZ MICROWAVE EXPOSURE IN RATS: TRANSCRIPTOMIC AND PROTEOMIC ANALYSIS

Zhao L, Yao C, Wang H, Dong J, Zhang J, Xu X, Wang H, Yao B, Ren K, Sun L, Peng R. Immune Responses to Multi- Frequencies of 1.5 GHz and 4.3 GHz Microwave Exposure in Rats: Transcriptomic and Proteomic Analysis. Int J Mol Sci. 2022 Jun 22;23(13):6949. doi: 10.3390/ijms23136949.

Abstract

With the rapidly increasing application of microwave technologies, the anxiety and speculation about microwave induced potential health hazards has been attracting more and more attention. In our daily life, people are exposed to complex environments with multi-frequency microwaves, especially L band and C band microwaves, which are commonly used in communications. In this study, we exposed rats to 1.5 GHz (L10), 4.3 GHz (C10) or multi-frequency (LC10) microwaves at an average power density of 10 mW/cm2. Both single and multi-frequency microwaves induced slight pathological changes in the thymus and spleen. Additionally, the white blood cells (WBCs) and lymphocytes in peripheral blood were decreased at 6 h and 7 d after exposure, suggesting immune suppressive responses were induced. Among lymphocytes, the B lymphocytes were increased while the T lymphocytes were decreased at 7 d after exposure in the C10 and LC10 groups, but not in the L10 group.

Moreover, multi-frequency microwaves regulated the B and T lymphocytes more strongly than the C band microwave. The results of transcriptomics and proteomics showed that both single and multi-frequency microwaves regulated numerous genes associated with immune regulation and cellular metabolism in peripheral blood and in the spleen. However, multi-frequency microwaves altered the expression of many more genes and proteins. Moreover, multi-frequency microwaves down-regulated T lymphocytes' development, differentiation and activation-associated genes, while they up-regulated B lymphocytes' activation-related genes. In conclusion, multi-frequency microwaves of 1.5 GHz and 4.3 GHz produced immune suppressive responses via regulating immune regulation and cellular metabolism-associated genes. Our findings provide meaningful information for exploring potential mechanisms underlying multi-frequency induced immune suppression.

Open access paper: https://www.mdpi.com/1422-0067/23/13/6949

ESTIMATION OF SOME ANTIOXIDANTS FOR PEOPLE EXPOSED TO ELECTROMAGNETIC WAVES FOR INTERNET TOWERS IN SAMARRA

Methaq Nazhan Mahmood, Asmaa Hashim Shaker, Humam E. Mohammed. Estimation of some antioxidants for people exposed to electromagnetic waves for Internet towers in Samarra. e79J Popul Ther Clin Pharmacol Vol 29(2):e79–e87; 16 June 2022. doi: 10.47750/jptcp.2022.934.

Abstract

The current study was conducted in Samarra city, as a preliminary study to explore the impact of the presence of Internet network towers inside cities and on residential homes and its impact on people exposed directly and indirectly. The study included collecting samples from people exposed to the radioactive frequencies of Internet towers for periods ranging from (1-5) years and from (5- 10) years. The number of samples was 43 samples of females and males exposed (present in the places where the constellations are located), and 20 samples not exposed (in places far from the towers) as a control group, and the ages ranged between (20-35) years. Analysis and measurements were made for some antioxidants because it is one of the most essential lines of defense against free radicals that cause many diseases and premature aging, which included the concentration of the enzyme glutathione peroxidase PGx, the enzyme superoxide dismutase SOD, glutathione GSH, dimalondhyde MDA, and ONOO. The results showed a significant increase in the level of glutathione peroxidase enzyme concentration and the concentration of superoxide dismutase in the blood serum for people exposed to electromagnetic waves from the Internet towers compared to the control group. The results also showed a significant decrease in the level of GSH in the blood serums of people exposed to electromagnetic waves of the Internet towers compared to the control group. The results also showed a significant increase in the concentration of both MDA and peroxynitrite ONOO compared to the non-exposed subjects in the control group.

Open access paper: https://www.jptcp.com/index.php/jptcp/article/view/934/895

MEASUREMENT AND IMAGE-BASED ESTIMATION OF DIELECTRIC PROPERTIES OF BIOLOGICAL TISSUES -PAST, PRESENT, AND FUTURE

Sasaki K, Porter E, Rashed EA, Farrugia L, Schmid G. Measurement and image-based estimation of dielectric properties of biological tissues -past, present, and future. Phys Med Biol. 2022;67(14):10.1088/1361- 6560/ac7b64. Published 2022 Jul 8. doi:10.1088/1361-6560/ac7b64.

Abstract

The dielectric properties of biological tissues are fundamental pararmeters that are essential for electromagnetic modeling of the human body. The primary database of dielectric properties compiled in 1996 on the basis of dielectric measurements at frequencies from 10 Hz to 20 GHz has attracted considerable attention in the research field of human protection from non-ionizing radiation. This review summarizes findings on the dielectric properties of biological tissues at frequencies up to 1 THz since the database was developed.

Although the 1996 database covered general (normal) tissues, this review also covers malignant tissues that are of interest in the research field of medical applications. An intercomparison of dielectric properties based on reported data is presented for several tissue types. Dielectric properties derived from image-based estimation techniques

developed as a result of recent advances in dielectric measurement are also included. Finally, research essential for future advances in human body modeling is discussed.
Open access paper: https://iopscience.iop.org/article/10.1088/1361-6560/ac7b64

EFFECTS OF PHONE MAST-GENERATED ELECTROMAGNETIC RADIATION GRADIENT ON THE DISTRIBUTION OF TERRESTRIAL BIRDS AND INSECTS IN A SAVANNA PROTECTED AREA

Nyirenda, V.R., Namukonde, N., Lungu, E.B. et al. Effects of phone mast-generated electromagnetic radiation gradient on the distribution of terrestrial birds and insects in a savanna protected area. Biologia (2022). https://doi.org/10.1007/s11756-022-01113-8

Abstract

Inappropriate deployment of linear physical infrastructures, such as game fences, roads, electric power-lines, buildings, and phone masts can be detrimental to wild fauna. Fatalities arising from wildlife collisions with such infrastructure have been widely documented. However, there are non-physical and less studied effects, such as the 'hidden' negative ecological effects of electromagnetic radiation (EMR) on terrestrial fauna. In this study, the effects of phone mast-generated EMR on abundance, richness and distribution of terrestrial birds and insects in the Kafue National Park were studied. Ten (10) sample plots of 100 m × 100 m each were set at three (3) radial locations, based on the phone mast generated EMR strengths. For birds, point counts, while hand collection, cryptic searching, vegetation beating, sweep netting, pitfall trapping, sorting and identification for insects were employed for data collection. Data were analysed using biological indices (i.e., Shannon-Wiener and Simpson's) and Analysis of Variance (ANOVA). The wildlife diversity significantly reduced with increasing EMR strengths, especially in areas (<12 km from phone mast) with greater than 250 ± 20 µA/m EMR levels. We suggest that deployment of wireless telecommunication infrastructure should take into account EMR levels, safe zones and avoid or minimize biological loss in hotspots. https://link.springer.com/article/10.1007/s11756-022-01113-8

LOCOMOTOR ACTIVITY OF IXODES RICINUS FEMALES IN 900 MHZ ELECTROMAGNETIC FIELD

Vargová B, Majláth I, Kurimský J, Cimbala R, Zbojovský J, Tryjanowski P, Majláthová V. Locomotor Activity of Ixodes ricinus Females in 900 MHz Electromagnetic Field. Life (Basel). 2022 Jun 13;12(6):884. doi: 10.3390/life12060884.

Abstract

Mobile telecommunications technologies have become an indispensable part of people's lives of all ages around the world. They affect personal life and social interactions and are a work tool in the work routine. Network availability requirements and the quality of the Internet connection are constantly increasing, to which telecommunications providers are responding. Humans and wildlife live in the permanent presence of electromagnetic radiation with just a minor knowledge of the impact this radiation has. The aim of our study was to investigate the effect of a 900 MHz electromagnetic field (EMF) on the locomotor behavior of female Ixodes ricinus ticks under laboratory conditions. Experiments were performed in the radiation-shielded tube (RST) test and radiation-shielded circular open-field arena placed in an anechoic chamber. Altogether, 480 female I. ricinus ticks were tested. In the RST arena, no differences in preference for irradiated and shielded parts of experimental modules were observed; in the open-field arena, the time spent and the trajectory passed was significantly longer in the part exposed to the EMF.

Conclusions

Cell phone use, an exponentially expanding phenomenon introducing electromagnetic load in the environment, inevitably has a biological effect on all living organisms. This does not exclude ticks, epidemiologically very important parasites. EMFs emit a very weak signal to animals (vertebrate and invertebrates), and the evidence of animal response to this signal may be diminished by the plethora of other, stronger signals. To provide evidence unequivocally showing the response to the presence of an EMF is difficult and needs different approaches, such as behavioral tests, and possibly evidence on molecular levels. The number of publications in this field is rising very slowly. In our pilot study, we determined that ticks reacted to the presence of a man- made EMF and a change in the I. ricinus female tick locomotor behavior occurred when exposed to 900 MHz frequency. In future studies, it is crucial to test other frequencies, other EMF sources, other tick species, and possibly use the results of behavioral tests as a starting point leading to studying the impact and the changes triggered by EMF exposure at the cellular or molecular level.

Open access paper: https://www.mdpi.com/2075-1729/12/6/884

UPTAKE OF NANOPARTICLES FROM SUNSCREEN PHYSICAL FILTERS INTO CELLS FROM INCREASED ENVIRONMENTAL MICROWAVE RADIATION: INCREASED POTENTIAL RISK OF USE OF SUNSCREENS TO HUMAN HEALTH

Horikoshi, S., Iwabuchi, M., Kawaguchi, M. et al. Uptake of nanoparticles from sunscreen physical filters into cells arising from increased environmental microwave radiation: increased potential risk of the use of sunscreens to human health. Photochem Photobiol Sci (2022). https://doi.org/10.1007/s43630-022-00259-3.

Abstract

This study examines the microwave chemical risks posed by photocatalysts present in sunscreens (physical filters) against the increasing use of microwaves (radio waves) in the environment, sometimes referred to as electronic smog. Specifically, the study assesses the damage caused by silica-coated physical filters (photocatalysts, TiO2· and/or ZnO) contained in commercially available sunscreens and fresh silica-coated ZnO for sunscreens to mouse skin fibroblasts cells (NIH/3T3) evaluated in vitro by the life/death of cells using two types of electromagnetic waves: UV light and microwave radiation, and under simultaneous irradiation with both UV light and microwaves. Conditions of the electromagnetic waves were such as to be of lower light irradiance than that of UVA/UVB radiation from incident sunlight, and with microwaves near the threshold power levels that affect human health. The photocatalytic activity of the physical filters was investigated by examining the degradation of the rhodamine B (RhB) dye in aqueous media and by the damage caused to DNA plasmids from E. coli. Compared to the photocatalytic activity of ZnO and TiO2 when irradiated with UV light alone, a clear enhanced photocatalytic activity was confirmed upon irradiating these physical filters concurrently with UV and microwaves. Moreover, the uptake of these metal oxides into the NIH/3T3 cells led to the death of these cells as a result of the enhanced photocatalytic activity of the metal oxides on exposure to microwave radiation.

Concluding Remarks

This study has demonstrated that the degradation of RhB and the degradation of DNA plasmids were promoted by two types of metal-oxide physical filters (ZnO and/or TiO2) in sunscreens when exposed to both UV and microwave radiations, with the irradiation output of the microwaves adjusted to a value close to the legal regulations. The effect of these photoactive filters on NIH/3T3 cells was also examined. In addition to the decomposition of the dye and the damage caused to the DNA plasmids by these photocatalytically active metal oxides, the study has also shown that nanoparticles of these physical filters are taken up by the cells under concurrent irradiation with ultraviolet rays and microwaves.

Although we did not discuss the risks to people on using sunscreens (however, see ref. [6]) and the effects of microwaves to human health, we hasten to point out that various catalytic reactions have been shown to be accelerated in Microwave Chemistry [29] as a result of the electromagnetic wave effects. The issue raised in this study is that if ZnO and/or TiO2 contained in cosmetics acted as photocatalysts under UV and UV/MW irradiation, in addition to scattering UV light (as suggested by many), any increase of the microwave intensity in the environment would certainly pose an increased risk to human health as evidenced by the damage caused to DNA plasmids. In addition, to the extent that the presence of metal oxides used as physical filters in sunscreens are activated by the UVA/UVB radiation (320–400 nm/290–320 nm), their simultaneous exposure to microwave radiation can also lead to or otherwise increase their uptake by the cells, a consequence of which can also pose potential risks to human health. https://link.springer.com/article/10.1007/s43630-022-00259-3

ELECTROMAGNETIC FIELD EFFECTS OF MARINE RADAR SYSTEMS ON THE SHIP CREW

Ünal Özdemir. Electromagnetic field effects of marine radar systems on the ship crew. Proceedings of the Institution of Mechanical Engineers, Part M: Journal of Engineering for the Maritime Environment. July 2022. doi:10.1177/14750902221107733.

Abstract

Marine radars become the sources of electromagnetic pollution during navigation and anchor watchkeeping. In several scientific studies, it was reported that electromagnetic fields could lead to several serious diseases, especially in the nervous system. In the current study, electromagnetic pollution is measured at different points on ships of various tonnage and types to identify electromagnetic pollution induced by marine radars. During these measurements, SRM 3006 compact spectrum analyzer (Narda Safety Test Solutions GmbH, Germany) that was operated within the 400 MHz–6 GHz frequency range was employed with a triaxial antenna. Then, the measurement results were compared with the benchmark published by ICNIRP (International Committee on Non-Ionizing Radiation Protection), and electromagnetic pollution levels induced by marine radar antennas and possible negative consequences for the crew were analyzed.

Conclusion

The study findings revealed that the radar-induced EMF generally exceeded the ICNIRP limits in the ships. This increased the possibility of adverse health outcomes due to the exposure of the crew to magnetic field pollution

for long periods of time. In future studies, it would be better to consider the problem from this perspective, especially that of the medical professional. Furthermore, future studies could conduct measurements during navigation or anchor watch to avoid external pollution in port environment to reach more accurate findings if the required financial resources could be provided. It could also be suggested that it would be beneficial to increase the sample size and develop various groups. Furthermore, since the measurements were conducted for 6 min, namely the limit specified in the ICNIRP guide, these were short-term spot measurements. However, continuous 24-h measurements over several days in a robust sample of ships would provide more realistic findings.

It could be suggested that the present study findings would provide a foundation for future IMO regulations, maritime industry policy makers, WMO and related institutions. It would be a correct approach to revise the mandatory MARPOL (International Convention for the Prevention of Pollution from Ships) and MLC (Maritime Labor Convention) conventions for IMO member nations, and to keep the issue of electromagnetic pollution in the maritime agenda. It was estimated that the topic will raise the interest of the maritime transportation industry in the future after certain number of studies are published on the topic, which is currently quite limited. https://journals.sagepub.com/doi/10.1177/14750902221107733

IS EXTREMELY LOW FREQUENCY PULSED ELECTROMAGNETIC FIELDS (EMF) APPLICABLE TO GLIOMAS? A LITERATURE REVIEW OF UNDERLYING MECHANISMS AND APPLICATION OF EXTREMELY LOW FREQUENCY PULSED EMF

Huang M, Li P, Chen F, Cai Z, Yang S, Zheng X, Li W. Is extremely low frequency pulsed electromagnetic fields applicable to gliomas? A literature review of the underlying mechanisms and application of extremely low frequency pulsed electromagnetic fields. Cancer Med. 2022 Aug 5. doi: 10.1002/cam4.5112.

Abstract

Gliomas refer to a group of complicated human brain tumors with a low 5-year survival rate and limited therapeutic options. Extremely low-frequency pulsed electromagnetic field (ELF-PEMF) is a specific magnetic field featuring almost no side effects. However, the application of ELF-PEMF in the treatment of gliomas is rare. This review summarizes five significant underlying mechanisms including calcium ions, autophagy, apoptosis, angiogenesis, and reactive oxygen species, and applications of ELF-PEMF in glioma treatment from a clinical practice perspective. In addition, the prospects of ELF-PEMF in combination with conventional therapy for the treatment of gliomas are reviewed. This review benefits any specialists, especially oncologists, interested in this new therapy because it can help treat patients with gliomas properly.

Open access paper: https://onlinelibrary.wiley.com/doi/10.1002/cam4.5112

VESTIBULAR EXTREMELY LOW-FREQUENCY MAGNETIC AND ELECTRIC STIMULATION EFFECTS ON HUMAN SUBJECTIVE VISUAL VERTICAL PERCEPTION

Bouisset N, Villard S, Legros A. Vestibular Extremely Low-Frequency Magnetic and Electric Stimulation Effects on Human Subjective Visual Vertical Perception. Bioelectromagnetics. 2022 Jul 8. doi: 10.1002/bem.22417.

Abstract

Electric fields from both extremely low-frequency magnetic fields (ELF-MF) and alternating current (AC) stimulations impact human neurophysiology. As the retinal photoreceptors, vestibular hair cells are graded potential cells and are sensitive to electric fields. Electrophosphene and magnetophosphene literature suggests different impacts of AC and ELF-MF on the vestibular hair cells. Furthermore, while AC modulates the vestibular system more globally, lateral ELF-MF stimulations could be more utricular specific. Therefore, to further address the impact of ELF-MF-induced electric fields on the human vestibular system and the potential differences with AC stimulations, we investigated the effects of both stimulation modalities on the perception of verticality using a subjective visual vertical (SVV) paradigm. For similar levels of SVV precision, the ELF-MF condition required more time to adjust SVV, and SVV variability was higher with ELF-MF than with AC vestibular-specific stimulations. Yet, the differences between AC and ELF-MF stimulations were small. Overall, this study highlights small differences between AC and ELF-MF vestibular stimulations, underlines a potential utricular contribution, and has implications for international exposure guidelines and standards. https://pubmed.ncbi.nlm.nih.gov/35801487/

THE SUBJECTIVE AND OBJECTIVE IMPROVEMENT OF NON-INVASIVE TREATMENT OF SCHUMANN RESONANCE IN INSOMNIA-A RANDOMIZED AND DOUBLE-BLINDED STUDY

Huang YS, Tang I, Chin WC, Jang LS, Lee CP, Lin C, Yang CP, Cho SL. The Subjective and Objective Improvement of Non-Invasive Treatment of Schumann Resonance in Insomnia-A Randomized and Double-Blinded Study. Nat Sci Sleep. 2022 Jun 8;14:1113-1124. doi: 10.2147/NSS.S346941.

Abstract

Purpose: Accumulated studies revealed that electromagnetic field can affect human brain and sleep, and the extremely low-frequency electromagnetic field, Schumann resonance, may have the potential to reduce insomnia symptoms. The purpose of this study was to investigate the responses of patients with insomnia to a non-invasive treatment, Schumann resonance (SR), and to evaluate its effectiveness by subjective and objective sleep assessments.

Patients and methods: We adopted a double-blinded and randomized design and 40 participants (70% female; 50.00 ± 13.38 year) with insomnia completed the entire study. These participants were divided into the SR- sleep-device group and the placebo-device group and were followed up for four weeks. The study used polysomnography (PSG) to measure objective sleep and used sleep diaries, Pittsburgh Sleep Quality Inventory (PSQI), Epworth Sleepiness Scale (ESS), and visual analogy of sleep satisfaction to measure subjective sleep. The 36-Item Short-Form Health Survey (SF-36) was used to evaluate quality of life. Chi-square test, Mann-Whitney U- test, and Wilcoxon test were used to analyze the data.

Results: About 70% of the subjects were women, with an average age of 50±13.38 years and an average history of insomnia of 9.68±8.86 years. We found that in the SR-sleep-device group, objective sleep measurements (sleep-onset-latency, SOL, and total-sleep-time, TST) and subjective sleep questionnaires (SOL, TST, sleep- efficiency, sleep-quality, daytime-sleepiness, and sleep-satisfaction) were significantly improved after using the SR-sleep-device; in the placebo-device group, only such subjective sleep improvements as PSQI and sleep- satisfaction were observed.

Conclusion: This study demonstrates that the SR-sleep-device can reduce the insomnia symptoms through both objective and subjective tests, with minimal adverse effects. Future studies can explore the possible mechanism of SR and health effects and, with a longer tracking time, verify the effectiveness and side effects.
Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9189153/

STATIC MAGNETIC FIELDS FROM EARPHONES: DETAILED MEASUREMENTS PLUS SOME OPEN QUESTIONS

L. Makinistian, L. Zastko, A. Tvarožná, L.E. Días, I. Belyaev. Static magnetic fields from earphones: Detailed
measurements plus some open questions. Environmental Research, 2022. doi: 10.1016/j.envres.2022.113907.

Highlights

- Experimental mapping of the static magnetic fields near 6 earphones.
- Physical modeling of the measured fields allows extrapolation and simulation.
- 3D simulations allow for visualization of field distribution in the ear.
- Field intensity and gradients, plus their combination with RF/ELF should be studied.

Abstract

Earphones (EP) are a worldwide, massively adopted product, assumed to be innocuous provided the recommendations on sound doses limits are followed. Nevertheless, sound is not the only physical stimulus that derives from EP use, since they include a built-in permanent magnet from which a static magnetic field (SMF) originates. We performed 2D maps of the SMF at several distances from 6 models of in-ear EP, showing that they produce an exposure that spans from ca. 20 mT on their surface down to tens of μT in the inner ear. The numerous reports of bioeffects elicited by SMF in that range of intensities (applied both acutely and chronically), together with the fact that there is no scientific consensus over the possible mechanisms of interaction with living tissues, suggest that caution could be recommendable. In addition, more research is warranted on the possible effects of the combination of SMF with extremely low frequency and radiofrequency fields, which has so far been scarcely studied. Overall, while several open questions about bioeffects of SMF remain to be addressed by the scientific community, we find sensible to suggest that the use of air-tube earphones is probably the more conservative, cautious choice.

Excerpt
The International Commission on Non-Ionizing Radiation Protection recommends a 400 mT exposure limit for the general public (ICNIRP, 2009), which are way above the SMF reported here. It must be noted that the recommendation is based on the effects of nausea, vertigo, photo phosphenes and nerve stimulation, well associated to high and ultra-high magnetic fields (typical of MRI facilities). All the other reported biological effects, which are not directly proven to be a health hazard (but could be, such being the case of the increase of reactive oxygen species (Wang and Zhang, 2017)) are disregarded by the recommendation.
https://www.sciencedirect.com/science/article/pii/S0013935122012348

DO MAGNETIC FIELDS RELATED TO SUBMARINE POWER CABLES AFFECT THE FUNCTIONING OF A COMMON BIVALVE?

Jakubowska-Lehrmann M, Białowąs M, Otremba Z, Hallmann A, Śliwińska-Wilczewska S, Urban-Malinga B. Do magnetic fields related to submarine power cables affect the functioning of a common bivalve? Mar Environ Res. 2022 Jul 11;179:105700. doi: 10.1016/j.marenvres.2022.105700.

Abstract
The aim of the study was to determine the effect of static magnetic field (SMF) and electromagnetic field (EMF), of values usually recorded near submarine cables, on the bioenergetics, oxidative stress, and neurotoxicity in the cockle Cerastoderma glaucum. Bivalves maintained a positive energy balance, but the filtration rate and energy available for individual production were significantly lower in SMF-exposed animals compared to the control treatment. No changes in the respiration were noted but ammonia excretion rate was significantly lower after exposure to EMF. Changes in the activities of antioxidant enzymes and the lipid peroxidation were not observed; however, exposure to both fields resulted in increased protein carbonylation. After exposure to EMF a significant inhibition of acetylcholinesterase activity was observed. As the present study for the first time revealed the oxidative damage and neurotoxicity in marine invertebrate after exposure to artificial magnetic fields, the need for further research is highlighted.
https://www.sciencedirect.com/science/article/pii/S0141113622001453?via%3Dihub

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THE IMPACT OF MAGNETIC FIELD ON INSECTICIDE TOXICITY MEASURED BY BIOLOGICAL AND BIOCHEMICAL PARAMETERS OF EARIAS INSULANA (BOLLWORM)

Hisham M El-Bassouiny, Warda A Z El-Medany, Mervat A A Kandil. The Impact of Magnetic Field on Insecticide Toxicity Measured by Biological and Biochemical Parameters of Earias insulana (Boisd). Bioelectromagnetics. 2022 Aug 5. doi: 10.1002/bem.22418.

Abstract
This study illustrates the effect of magnetic field (MF) on the toxicity of two insecticides, emamectin benzoate (Emazoate 2.15% EC) and spinosad (SpinTor 24% SC), and determines their adverse effects on the bollworm (Earias insulana) through various biological and biochemical assays. The investigation indicated that exposure to the insecticides in a MF of 180 mT resulted in stronger toxicity, with LC50 values of 0.162, 1.211, and 1.770 ppm, respectively. In addition, the results showed that magnetized insecticides significantly increased in the duration of the total immature stages (larvae and/or pupae) 32.1 and 36.6 days, compared with 27.9 and 30.5 days, respectively, in the nonmagnetized insecticides,

while untreated check was 21 days. Also, the magnetized insecticides reduced the percentage of adult emergence, and increased deformations in the larval and pupal stages. Furthermore, sex ratio was greatly affected by exposure to both insecticides in conjunction with the MF. Exposure of the larvae of E insulana to magnetized insecticides can bring about malfunction in some biochemical process and significantly decreased the invertase activity, and decreased the total protein and carbohydrates. In contrast, it can increase amylase compared with nonmagnetized insecticides and untreated controls. Results concluded that the two insecticides' MF affected growth, survival time, and biological and biochemical parameters of E. insulana. https://pubmed.ncbi.nlm.nih.gov/35930550/

SELF-REFERENCING AUTHORSHIPS BEHIND THE ICNIRP 2020 RADIATION PROTECTION GUIDELINES

Else K Nordhagen, Einar Flydal. Self-referencing authorships behind the ICNIRP 2020 radiation protection guidelines. Rev Environ Health. 2022 Jun 27. doi: 10.1515/reveh-2022-0037.

Abstract

In March 2020, ICNIRP (the International Commission for Non-Ionizing Radiation Protection) published a set of guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz). ICNIRP claims this publication's view on EMF and health, a view usually termed "the thermal-only paradigm", is consistent with current scientific understanding. We investigated the literature referenced in ICNIRP 2020 to assess if the variation in authors and research groups behind it meets the fundamental requirement of constituting a broad scientific base and thus a view consistent with current scientific understanding, a requirement that such an important set of guidelines is expected to satisfy. To assess if this requirement has been met, we investigated the span of authors and research groups of the referenced literature of the ICNIRP 2020 Guidelines and annexes. Our analysis shows that ICNIRP 2020 itself, and in practice all its referenced supporting literature stem from a network of co-authors with just 17 researchers at its core, most of them affiliated with ICNIRP and/or the IEEE, and some of them being ICNIRP 2020 authors themselves. Moreover, literature reviews presented by ICNIRP 2020 as being from independent committees, are in fact products of this same informal network of collaborating authors, all committees having ICNIRP 2020 authors as members. This shows that the ICNIRP 2020 Guidelines fail to meet fundamental scientific quality requirements and are therefore not suited as the basis on which to set RF EMF exposure limits for the protection of human health. With its thermal-only view, ICNIRP contrasts with the majority of research findings, and would therefore need a particularly solid scientific foundation. Our analysis demonstrates the contrary to be the case. Hence, the ICNIRP 2020 Guidelines cannot offer a basis for good governance.

Excerpts

ICNIRP members are found to have conflicts of interest, as pointed out by e.g., [3]: “the Ethical Board at the Karolinska Institute in Stockholm, Sweden concluded already in 2008 that being a member of ICNIRP may be a conflict of interest that should be stated officially whenever a member from ICNIRP makes opinions on health risks from EMF (Karolinska Institute diary number: 3753-2008-609)”. An EU report [4] concluded in June 2020 that “for really independent scientific advice we cannot rely on ICNIRP”....

As is apparent from the debate on this issue, a majority of peer-reviewed papers support the opposing view, i.e., that sub-thermal RF EMFs have health effects [5]. Several athermal mechanisms have been identified [6], [7], [8], [9], [10] and accepted as evidenced, if not proven....

All in all, ICNIRP 2020 has 158 unique references. Not all have been authored by the ICNIRP co-authorship network found in Pattern 1. We found that the network co-authored 78 of the referenced peer reviewed papers, seven of the literature reviews, and six ICNIRP publications, in total 91 documents. In addition to these 91 documents, there are 67 references to other documents.

Of these 67 documents, only 15 are peer reviewed papers on RF EMF and health. The remaining 52 are documents with no direct relation to this topic. We termed these 52 "technical documents", as they address topics such as WHO's definition of "health" and other general terms used (three documents), thermal regulation (20 documents), contact currents and pain (five documents), technical documentation (three documents) and SAR-modelling and calculations (21 documents). We excluded these technical documents from further analyses (see Figure 1) ....

Conclusions

In the introduction we raised five questions relating to the authorship behind the referenced literature used to underpin the ICNIRP 2020 thermal-only view. Below we repeat the patterns found, answering these questions whilst adding some overarching conclusions.

Pattern 1: ICNIRP affiliates and ICNIRP 2020 authors are heavily involved in literature referenced in ICNIRP 2020 to underpin it. Figure 2 shows the graph of the complete network of co-authorship relations found in the referenced literature in ICNIRP 2020 originating from the ICNIRP affiliates, displaying that ICNIRP affiliates are the most central nodes of the network, and seven of the most central nodes being ICNIRP 2020 authors.

Pattern 4: a small and tight network of just 17 authors is behind all the literature used to underpin ICNIRP 2020. Of these 17, 10 were ICNIRP affiliates, of whom six were also authors of ICNIRP 2020. Five of these 17 were IEEE C95.1 2019 authors, two of whom were also ICNIRP 2020 authors.

Pattern 2: ICNIRP 2020 authors are involved in all the literature reviews referenced in ICNIRP 2020 to underpin it. In addition to the ICNIRP 2020 authors, these committees are manned by several other ICNIRP affiliates.

Pattern 3: All scientific papers used to underpin ICNIRP 2020 are from the same co-author network centered around ICNIRP affiliates.

Only four papers were found to be used to underpin ICNIRP 2020 that were not linked to the ICNIRP co- authorship network. Of these four, a simple internet search revealed that two of them have authors who have co-authored several papers with ICNIRP affiliates and thus cannot be seen as independent from ICNIRP. The two last were misinterpreted to underpin ICNIRP 2020 or offered no scientifically sound support.

Pattern 5: The spread of first authors gives a false impression of broad support. While there is a high variation of first authors, most of them not affiliated with ICNIRP/IEEE, a tight network of just 16 key authors, dominated by ICNIRP and IEEE affiliates, is involved in all the papers used to underpin ICNIRP 2020 (Pattern 4). Moreover, in the co-authorship network (Pattern 1) ICNIRP affiliates are found as central nodes, while most first authors are peripheral in the network.

Intentionally or not, the domination of ICNIRP affiliated authorship is blurred by the practice of having many different non-affiliates as first authors. This conceals the fact that effectively all referenced papers used to support ICNIRP 2020 originate from a network of researchers completely dominated by ICNIRP affiliates and a few who are closely related.

Pattern 6: All referenced papers not authored by the ICNIRP co-authorship network are either rejected, misinterpreted to underpin ICNIRP 2020, or offer no scientifically sound support.

Our analysis shows that ICNIRP 2020 itself and, in practice, all its referenced supportive literature stem from a network of co-authors with just 17 researchers at its core, most of them affiliated with ICNIRP and/or the IEEE and with ICNIRP 2020 authors in prominent positions, where those who are not are still closely related.

The overlaps between ICNIRP and the committees authoring the referenced literature reviews have been documented multiple times [4, 19, 20]. However, it was not anticipated that these ties would be so strong, that they include all committees behind the literature reviews, as well as the authorships of all the peer reviewed papers used to underpin ICNIRP 2020. Indeed, we would never have expected to find as few as 17 key authors as the smallest set of authors involved in all the literature used to underpin the ICNIRP 2020, and that they constitute a network heavily overlapping with the ICNIRP 2020 authors themselves. It was also not anticipated that the ICNIRP 2020 authors themselves would be represented in all committees. This means that the authors of ICNIRP 2020 are exclusively referring to themselves and their fellow network members as the basis for their own scientifically highly controversial recommendations.

As well, it was highly unexpected to find that the WHO report [11] described in ICNIRP 2020 as “an in-depth review from the World Health Organization on radiofrequency EMF exposure and health” [2 p. 486] and presented in these words: “This independent review is the most comprehensive and thorough appraisal of the adverse effects of radiofrequency EMFs on health” [2 p. 517], is in fact a retracted draft where five out of six WHO core group members were ICNIRP affiliates, of whom three are among the authors of ICNIRP 2020. Such a claim and circularity of authorship is encroaching upon something very similar to fraud.

From our findings we draw the conclusion that the referenced literature used in ICNIRP 2020 to underpin its guidelines is neither varied, nor independent or balanced, and is by no means “consistent with current scientific knowledge”, as claimed by ICNIRP 2020 [2 p. 484]. ICNIRP 2020 bases this claim within this small network only, a claim that runs contrary to the majority of biology-oriented researchers and publications within this research field. Hence, our review shows that the ICNIRP 2020 guidelines fail to meet fundamental scientific quality

requirements as to being built on a broad, solid and established knowledge base, uphold a view contrary to well established knowledge within the field, and therefore cannot offer a basis for good governance when setting RF exposure limits for the protection of human health.
Open access paper: https://www.degruyter.com/document/doi/10.1515/reveh-2022-0037/html

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PROTECTION OF WORKERS EXPOSED TO RADIOFREQUENCY ELECTROMAGNETIC FIELDS: A PERSPECTIVE ON OPEN QUESTIONS IN THE CONTEXT OF THE NEW ICNIRP 2020 GUIDELINES
Jeschke P, Alteköster C, Hansson Mild K, Israel M, Ivanova M, Schiessl K, Shalamanova T, Soyka F, Stam R, WilénJ. Protection of Workers Exposed to Radiofrequency Electromagnetic Fields: A Perspective on Open Questions in the Context of the New ICNIRP 2020 Guidelines. Front Public Health. 2022 Jun 2;10:875946. doi: 10.3389/fpubh.2022.875946.

Abstract
Workers in occupational settings are usually exposed to numerous sources of electromagnetic fields (EMF) and to different physical agents. Risk assessment for industrial workplaces concerning EMF is not only relevant to operators of devices or machinery emitting EMF, but also to support-workers, bystanders, service and maintenance personnel, and even visitors. Radiofrequency EMF guidelines published in 2020 by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) may also be indirectly applied to assess risks emerging from EMF sources at workplaces by technical standards or legislation. To review the applicability and adequacy to assess exposure to EMF in occupational settings in the European Union, the most current ICNIRP guidelines on radiofrequency EMF are reviewed. Relevant ICNIRP fundamentals and principles are introduced, followed by practical aspects of exposure assessment. To conclude, open questions are formulated pointing out gaps between the guidelines' principles and occupational practice, such as the impact of hot and humid environments and physical activity or controversies around ICNIRP's reduction factors in view of assessment uncertainty in general. Thus, the article aims to provide scientific policy advisors, labor inspectors, or experts developing standards with a profound understanding about ICNIRP guidelines' applicability to assess hazards related to radiofrequency EMF in occupational settings.

Concluding Remarks

We highly acknowledge the effort and scientific quality that is shown by ICNIRP 2020 (1). This review aims to foster a constructive dialogue aimed at future improvements. Based on previous experiences with the implementation of ICNIRP guidelines in OSH [occupational safety and health] risk assessment, it became necessary to reflect the 2020 ICNIRP RF EMF guidelines (1) in the light of OSH risk assessment practice.

Occupational exposure settings differ significantly to those of the general public, with the latter ones focusing more or less on the application of mobile communication with limited frequency ranges and exposure levels. In contrast, occupational exposure is permitted at levels 5 times larger than the general public, across the whole frequency range from 100 kHz to 300 GHz with unlimited exposure durations. ICNIRP did not provide practical details relevant to OSH exposure assessment and occupational exposure durations during working

hours over decades as well as its effects. Some of these details could be addressed in an updated version of the non-binding guide for the EMF Directive (8, 9) or could be provided in relevant technical standards. Other, more fundamental choices that are necessary to provide legal clarity could be addressed in a possible revision of the EMF directive.

The removal of non-adverse health effects, e.g., the microwave hearing effect, is questionable for OSH purposes. In consequence, a solid anchor in OSH legislation is required to provide a reliable basis to evaluate distracting effects, even if they are not adverse to health, in OSH risk assessments.

In addition, several open questions regarding ICNIRP's (1) practical implementation were identified and discussed in the present review. It is acknowledged that ICNIRP itself has no intention nor obligation to consider the practical application of its guidelines in OSH tasks, such as workplace risk assessment. As challenging as it might be, such considerations are clearly needed for a reliable OSH risk assessment practice. Those considerations are yet to be developed, along with appropriate measurement devices. To facilitate a holistic understanding and application of ICNIRP 2020 (1), a set of BR and RL [Basic Restrictions and Reference Levels] which are easy to comprehend is desirable for OSH practitioners. Furthermore, any doubt on conservativeness, for all possible occupational scenarios is disadvantageous, and should be avoided by an appropriate selection of BR and RL. Considering policy makers at a European and member states level, OSH EMF-legislation would benefit greatly from an adopted safety concept, comprising a comprehensible set BR and RL for all substantiated RF EMF effects, regardless of whether they are adverse to health or distracting.
Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9215329/

SYSTEMATIC REVIEW OF THE PHYSIOLOGICAL AND HEALTH-RELATED EFFECTS OF RADIOFREQUENCY ELECTROMAGNETIC FIELD EXPOSURE FROM WIRELESS COMMUNICATION DEVICES ON CHILDREN AND ADOLESCENTS IN EXPERIMENTAL AND EPIDEMIOLOGICAL HUMAN STUDIES

Bodewein L, Dechent D, Graefrath D, Kraus T, Krause T, Driessen S (2022) Systematic review of the physiological and health-related effects of radiofrequency electromagnetic field exposure from wireless communication devices on children and adolescents in experimental and epidemiological human studies. PLoS ONE 17(6): e0268641. doi: 10.1371/journal.pone.0268641.

Abstract

Background For more than 20 years, the potential health risks of radiofrequency electromagnetic field (RF EMF) exposure from mobile communication devices on children and adolescents have been examined because they are considered sensitive population groups; however, it remains unclear whether such exposure poses any particular risk to them.

Objectives The aim of this review was to systematically analyze and evaluate the physiological and health- related effects of RF EMF exposures from wireless communication devices (mobile phones, cordless phones, Bluetooth, etc.) on children and adolescents.

Methods This review was prepared according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Methodological limitations in individual studies were assessed using the Office of Health Assessment and Translation (OHAT) Risk-of-Bias Rating Tool for Human and Animal Studies.

Results A total of 42 epidemiological and 11 experimental studies were eligible for this review. Most of the studies displayed several methodological weaknesses that limited the internal validity of the results. Due to a lack of consistency regarding the outcomes as well as the lack of scientific rigor in most reviewed studies, the body of evidence for the effects of RF EMF of mobile communication devices on subjective symptoms, cognition, and behavior in children and adolescents was low to inadequate. Evidence from the studies investigating early childhood development, brain activity, cancer, and physiological parameters was considered inadequate for drawing conclusions about possible effects.

Discussion Overall, the body of evidence allows no final conclusion on the question whether exposure to RF EMF from mobile communication devices poses a particular risk to children and adolescents. There has been rapid development in technologies generating RF EMF, which are extensively used by children and adolescents. Therefore, we strongly recommend high-quality systematic research on children and adolescents, since they are generally considered as sensitive age groups.

Excerpts

"From a total of 42 epidemiological studies, 10 studies found consistent associations between mobile phone exposure and health effects on children and adolescents, 23 studies found limited associations, and 9 studies did not find any consistent associations (Fig 4) In summary, the evidence for physiological and health-related effects of mobile communication RF EMF (mobile phones, wireless phones, WLAN, Bluetooth, etc.) on children and adolescents was rated as low to inadequate overall, based on the included epidemiological studies in this review."

"Out of a total of 11 experimental studies, 3 of them including a total of 116 children and adolescents found an effect of mobile phone exposure on brain activity and cognition, whereas the remaining 8 studies, with a total of 222 children and adolescents, could not identify any effects (Fig 4) As the experimental studies included in this review only investigated acute and short-term effects, no conclusion can be drawn regarding potential long- term effects. In summary, the evidence from the included experimental studies is inadequate to draw a conclusion regarding mobile phone-related exposure and its effects on cognition, brain activity, and physiological changes in children and adolescents."

"As the OHAT risk-of-bias tool was used to assess the risk of bias in each study as a whole, the assessment utilizing the “confidence in the exposure” criterion might not represent the true risk of bias in every individual exposure assessment method in epidemiological studies with different exposure sources and assessment methods (e.g., mobile phone use assessed by questionnaire, mobile phone base station exposure assessed by measurements). This may have led to an over- or underestimation in the risk of bias in single epidemiological studies."

Conclusion

"In this review, 42 epidemiological and 11 experimental studies on children and adolescents were systematically researched, analyzed, and assessed in view of the health-related effects of RF EMF from wireless communication devices (mobile phones, cordless phones, WLAN, Bluetooth, etc.). A total of 50 studies investigated mobile phone usage, 3 studies examined the exposure to mobile phone base stations, and 22 studies investigated both mobile phone usage and exposure to cordless phones, mobile phone base stations, etc.

Of a total of 53 included studies, 35 studies had several methodological weaknesses, which limited the internal validity of the results. Overall, evidence for the effects of RF EMF of mobile communication devices on subjective symptoms, cognition, and behavior in children and adolescents was considered to be low to inadequate. Furthermore, the studies investigating early childhood development, brain activity, cancer, and physiological parameters were considered inadequate to draw conclusions concerning possible effects. Based on the studies included in this review, it remains unclear whether children and adolescents are particularly sensitive to mobile communication exposure.

In summary, we could not identify a high evidence for any significant detrimental health effects of RF EMF of mobile communications on children and adolescents. Nevertheless, we do not conclude that such exposure would be safe for this particular age group, since the evidence base for this conclusion is too weak.

There has been rapid development in technologies generating RF EMF, which are extensively used by children and adolescents. Therefore, we strongly recommend high-quality systematic research on children and adolescents, since they are generally considered as sensitive age groups [13]. For example, cohort studies with improved exposure assessments and experimental studies investigating the nervous systems, including larger study populations and different age groups, should be conducted. Moreover, children and adolescents should be considered separately in future trend studies.

The conclusions of this review are largely in line with the evaluation of the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) [28] and the conclusions of other authors of earlier studies [7, 26, 27, 118]."

Open access paper:
https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0268641

PROTECTION OF WORKERS EXPOSED TO RADIOFREQUENCY ELECTROMAGNETIC FIELDS: A PERSPECTIVE ON OPEN QUESTIONS IN THE CONTEXT OF THE NEW ICNIRP 2020 GUIDELINES

Jeschke Peter, Alteköster Carsten, Hansson Mild Kjell, Israel Michel, Ivanova Mihaela, Schiessl Klaus, Shalamanova Tsvetelina, Soyka Florian, Stam Rianne, Wilén Jonna. Frontiers in Public Health, 10, 2022, doi: 10.3389/fpubh.2022.875946

Abstract

Workers in occupational settings are usually exposed to numerous sources of electromagnetic fields (EMF) and to different physical agents. Risk assessment for industrial workplaces concerning EMF is not only relevant to operators of devices or machinery emitting EMF, but also to support-workers, bystanders, service and maintenance personnel, and even visitors. Radiofrequency EMF guidelines published in 2020 by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) may also be indirectly applied to assess risks emerging from EMF sources at workplaces by technical standards or legislation. To review the applicability and adequacy to assess exposure to EMF in occupational settings in the European Union, the most current ICNIRP guidelines on radiofrequency EMF are reviewed. Relevant ICNIRP fundamentals and principles are introduced, followed by practical aspects of exposure assessment. To conclude, open questions are formulated pointing out gaps between the guidelines' principles and occupational practice, such as the impact of hot and humid environments and physical activity or controversies around ICNIRPS's reduction factors in view of assessment uncertainty in general. Thus, the article aims to provide scientific policy advisors, labor inspectors, or experts developing standards with a profound understanding about ICNIRP guidelines' applicability to assess hazards related to radiofrequency EMF in occupational settings.

Concluding Remarks

We highly acknowledge the effort and scientific quality that is shown by ICNIRP 2020 (1). This review aims to foster a constructive dialogue aimed at future improvements. Based on previous experiences with the implementation of ICNIRP guidelines in OSH [occupational safety and health] risk assessment, it became necessary to reflect the 2020 ICNIRP RF EMF guidelines (1) in the light of OSH risk assessment practice.

Occupational exposure settings differ significantly to those of the general public, with the latter ones focussing more or less on the application of mobile communication with limited frequency ranges and exposure levels. In contrast, occupational exposure is permitted at levels 5 times larger than the general public, across the whole frequency range from 100 kHz to 300 GHz with unlimited exposure durations. ICNIRP did not provide practical details relevant to OSH exposure assessment and occupational exposure durations during working hours over decades as well as its effects. Some of these details could be addressed in an updated version of the non-binding guide for the EMF Directive (8, 9) or could be provided in relevant technical standards. Other, more fundamental choices that are necessary to provide legal clarity could be addressed in a possible revision of the EMF directive.

The removal of non-adverse health effects, e.g., the microwave hearing effect, is questionable for OSH purposes. In consequence, a solid anchor in OSH legislation is required to provide a reliable basis to evaluate distracting effects, even if they are not adverse to health, in OSH risk assessments.

In addition, several open questions regarding ICNIRP's (1) practical implementation were identified and discussed in the present review. It is acknowledged that ICNIRP itself has no intention nor obligation to consider the practical application of its guidelines in OSH tasks, such as workplace risk assessment. As challenging as it might be, such considerations are clearly needed for a reliable OSH risk assessment practice. Those considerations are yet to be developed, along with appropriate measurement devices. To facilitate a holistic understanding and application of ICNIRP 2020 (1), a set of BR and RL [Basic Restrictions and Reference Levels] which are easy to comprehend is desirable for OSH practitioners. Furthermore, any doubt on conservativeness, for all possible occupational scenarios is disadvantageous, and should be avoided by an appropriate selection of BR and RL. Considering policy makers at a European and member states level, OSH EMF-legislation would benefit greatly from an adopted safety concept, comprising a comprehensible set BR and RL for all substantiated RF EMF effects, regardless of whether they are adverse to health or distracting.

Open access paper: https://www.frontiersin.org/article/10.3389/fpubh.2022.875946

IEC/IEEE DRAFT STANDARD FOR DETERMINING THE SAR FROM WIRELESS DEVICES, 30 MHZ TO 6 GHZ. PART 1: GENERAL REQUIREMENTS FOR USING THE FINITE DIFFERENCE TIME DOMAIN (FDTD) METHOD

International Electrotechnical Commission (IEC), Institute of Electrical and Electronics Engineers (IEEE). IEC/IEEE Draft Standard for Determining the Peak Spatial Average Specific Absorption Rate (SAR) in the Human Body from Wireless Communications Devices, 30 MHz to 6 GHz. Part 1: General Requirements for using the Finite Difference Time Domain (FDTD) Method for SAR Calculations. 2022, IEEE/IEC P62704-1: 1-82.

Abstract

This standard defines the methodology for the application of the finite difference time domain (FDTD) technique when used for determining the peak spatial-average specific absorption rate (SAR) in the human body exposed to wireless communication devices with known uncertainty. It defines methods to validate the numerical model of the device under test (DUT) and to assess its uncertainty when used in SAR simulations. Moreover, it defines procedures to determine the peak spatial average SAR in a cubical volume and to validate the correct implementation of the FDTD simulation software. This document does not recommend specific SAR limits since these are found elsewhere, e.g., in the guidelines published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) or in IEEE C95.1

https://standards.ieee.org/ieee/62704-1/10440/

BIOLOGICAL AND MEDICAL DISTURBANCES DUE TO EXPOSURE TO FIELDS EMITTED BY ELECTROMAGNETIC ENERGY DEVICES—A REVIEW

Adel Razek. Biological and Medical Disturbances Due to Exposure to Fields Emitted by Electromagnetic Energy Devices—A Review. Energies. 2022; 15(12):4455. doi:10.3390/en15124455.

Abstract

The use of electromagnetic systems in daily life is on the rise. The immediate environment, of these electromagnetic energy devices, is exposed to their emitted fields. Environmental disturbances from such exposure could be severe in many ways; one of the most important is health. This could be directly related to the human body or to healthcare sensing and interventional devices. The review of the biological effects and disturbances of medical instruments due to electromagnetic field exposure is the subject of this article. The analysis of the different types of exposure as well as their control to meet safety requirements are investigated involving energy devices covering wide ranges of power and frequency. Thus, biological effects of both wireless telecommunications tools and inductive charging systems are reviewed. Next, we survey electromagnetic disturbances in sensing and stimulation instruments joint to the human body as well as devices used in medical interventions. Means of evaluating and controlling the effects of electromagnetic fields, through electromagnetic compatibility analysis, experimentally and by numerical modeling are conferred and assessed. https://www.mdpi.com/1996-1073/15/12/4455

A CO-POLARIZATION-INSENSITIVE METAMATERIAL ABSORBER FOR 5G N78 MOBILE DEVICES AT 3.5 GHZ TO REDUCE THE SPECIFIC ABSORPTION RATE

Hannan S, Islam MT, Soliman MS, Faruque MRI, Misran N, Islam MS. A co-polarization-insensitive metamaterial absorber for 5G n78 mobile devices at 3.5 GHz to reduce the specific absorption rate. Sci Rep 12, 11193 (2022). doi:10.1038/s41598-022-15221-7.

Abstract

Specific absorption rate (SAR) by next-generation 5G mobile devices has become a burning question among engineers worldwide. 5G communication devices will be famous worldwide due to high-speed data transceiving, IoT-based mass applications, etc. Many antenna systems are being proposed for such mobile devices, but SAR is found at a higher rate that requires reduced for human health. This paper presents a metamaterial absorber (MMA) for SAR reduction from 5G n78 mobile devices at 3.5 GHz. The MMA is co-polarization insensitive at all possible incident angles to ensure absorption of unnecessary EM energies obeying the Poynting theorem for energy conservation and thus ensuring smooth communication by the devices. The unit cell size of the absorber is 0.114 λ making it design efficient for array implementation into mobile devices. This absorber has achieved a minimum of 33% reduction of SAR by applying it to the 5G n78 mobile phone model, equivalent to SAR by GSM/LTE/UMTS band mobile phones and making it suitable for SAR reduction from next-generation 5G mobile devices.

Conclusion

In this study, we numerically studied the SAR reduction from next-generation 5G n78 mobile devices by applying a novel co-polarization-insensitive metamaterial absorber (MMA) and experimentally verified the absorptivity of the MMA at the resonance frequency. The MMA

was designed to aim the resonance frequency at 3.5 GHz with metamaterial characteristics by the necessary engineering of L-C-R transmission lines as per the equivalent circuit. However, it is essential to mention that the metamaterial was designed with a modified circular split-ring resonator so that it cannot be rotationally symmetric 13, 29 and thus be able to absorb the co-polarized portion of the applied EM wave only. This property made it appropriate to be used inside 5G mobile phones for both smooth communication and SAR reduction. However, as perfect MMA can absorb entire applied EM waves of both the co-polar and the cross-polar elements, they will not be suitable for applying to mobile phones or other similar devices due to the entire signal absorption capability that can hamper EM signal, even if they can reduce SAR effectively. Furthermore, the proposed MMA has shown at least a 33% reduction of SAR from n78 5G mobile phones and maintained the SAR value equivalent to GSM/ LTE/ UMTS bands for the 5G band, a benchmark set by the proposed absorber.
https://www.nature.com/articles/s41598-022-15221-7

INSTRUMENTS TO MEASURE ENVIRONMENTAL AND PERSONAL RADIOFREQUENCY-ELECTROMAGNETIC FIELD EXPOSURES: AN UPDATE

Bhatt, C.R., Henderson, S., Brzozek, C., Benke, G.Phys Eng Sci Med (2022). doi: 10.1007/s13246-022- 01146-y.

Abstract

Modern human populations are exposed to anthropogenic sources of radiofrequency-electromagnetic fields (RF-EMFs), primarily to telecommunication and broadcasting technologies. As a result, ongoing concerns from some members of the public have arisen regarding potential health effects following RF-EMF exposures. In order to monitor human RF-EMF exposures and investigate potential health effects, an objective assessment of RF-EMF exposures is necessary. Accurate dosimetry is essential for any investigation of potential associations between RF-EMF exposure and health effects in human populations. This review updates state-of-the-art knowledge of currently available RF-EMF exposure assessment tools applicable in human epidemiological studies. These tools cater for assessing RF-EMF exposures in human environments; through mobile phone-based tools or other standalone tools. RF-EMF exposure assessment has been significantly improved through the application of some of these tools in recent years.

Conclusion

This updated review includes most currently used tools for environmental and personal RF-EMF assessment. These tools, involving both mobile phone-based and standalone RF-EMF exposure assessment instruments, provide useful objective measurements of RF-EMF exposures associated with broadcast and telecommunication technologies. Most of these instruments have been validated through recent epidemiological studies conducted internationally. These tools have demonstrated capabilities in providing RF-EMF exposure data for current and future human epidemiological studies. The future research and development in the science of RF-EMF exposure assessment could consider tools that would enable exposure assessment in relation to a wide range of currently available RF-EMF emitting sources, such as cordless and mobile phones, tablet devices and laptop computers. The need for further development of exposimeters or radiation meters that could measure mmWave frequencies is also necessary.
Open access paper: https://link.springer.com/article/10.1007/s13246-022-01146-y

ASSESSMENT OF RADIOFREQUENCY EXPOSURE IN THE VICINITY OF SCHOOL ENVIRONMENTS IN CRETE ISLAND, SOUTH GREECE

Theodore N. Kapetanakis, Melina P. Ioannidou, Anargyros T. Baklezos, Christos D. Nikolopoulos, Eleftheria S. Sergaki, Antonios J. Konstantaras, Ioannis O. Vardiambasis. 2022. Assessment of Radiofrequency Exposure in the Vicinity of School Environments in Crete Island, South Greece. Applied Sciences 12(9):4701. doi: org/10.3390/app12094701

Abstract

This study aimed to estimate the radiofrequency exposure levels in the vicinity of nursery and primary schools at the northwest part of Crete island in Greece. Moreover, the compliance with the exposure limits, according to Greek legislation, was investigated. A total of 396 in situ frequency-selective and broadband measurements were conducted around 69 schools, classified in urban and suburban environments, in the range of 27–3000 MHz (subdivided in seven frequency bands). The measured value of the electric field strength (V/m) was recorded and, subsequently, the exposure ratio was calculated. Statistical analysis was performed in order to analyze and evaluate the data. In addition, a worst-case scenario was examined by considering the highest measured exposure level around each school. The statistical tests indicated that the mean and median values of the exposure ratio, even in the worst-case scenario, were found well below 1 for all frequency bands. The calculated distributions of the electric field measurements demonstrated that almost 90% of the latter were below 1 V/m, with the majority of values lying in the range of 0.5–1 V/m. The main contributors to the total exposure were the mobile communication frequencies and broadcasting, while the exposure was greater in urban than in suburban environments.

Conclusions

In conclusion, our results indicate that, in the vast majority of cases, we observed compliance with the Greek established reference levels for RF exposure. The median values of the exposure ratio were found less than 0.035 in all cases examined, whereas the maximum values of the exposure ratio lay below 0.28 except for a very few cases, where the maximum value of the E-field strength exceeded the reference level. Most recordings of the electric field strength (i.e., 90%) were found lower than 1 V/m, while the majority of the total exposure ratio values (i.e., almost 94%) were below 0.2. The median values of the E-field strength were found to be statistically significantly different in urban and suburban environments, except for the 27–879 MHz band where broadcast applications dominate. Readings were slightly higher in urban areas than in the suburbs and the latter exhibited a narrower interquartile range than the former due to their more uniform construction. We also found that mobile communication frequencies and broadcast were the sources that contributed most to the total exposure.

Our future plans include EMF measurements not only around but also inside schools and classrooms, in the frequency range of 27 MHz–6 GHz, especially with the prospect of the rapidly upcoming 5G mobile services everywhere. A comparison of the electric field strength at the same measurement locations, before and after the advent of 5G, will be interesting and revealing.

Open access paper: https://www.mdpi.com/2076-3417/12/9/4701/htm

IMPACT OF SMALL-CELL DEPLOYMENT ON COMBINED UPLINK AND DOWNLINK RF EXPOSURE COMPARED TO THE STATUS QUO IN MOBILE NETWORKS

L. M. Schilling, C. Bornkessel and M. A. Hein. Impact of Small-Cell Deployment on Combined Uplink and Downlink RF Exposure Compared to the Status Quo in Mobile Networks. 2021 51st European Microwave Conference (EuMC), 2022, pp. 618-621, doi: 10.23919/EuMC50147.2022.9784284.

Abstract

As new cellular technologies are introduced in mobile networks nowadays, more and more small cells and mobile road side units are being deployed to upgrade the performance of the wireless communication network. With regard to the overall human RF exposure, the question arises to what extent the exposure is affected by the deployment of such small cells compared to macro cells as the status quo. In an attempt to answer this important question, this paper proposes a method to measure and evaluate the combined uplink and downlink exposure in terms of the specific absorption rate of a mobile phone user at recently installed small cell locations. The comparison between the small cell and macro cell scenarios revealed a reduction of the total exposure when the user equipment was logged into the investigated LTE small cells, although the downlink exposure increased. The main reason for this encouraging result is the reduction of the uplink transmission power due to the improved link conditions across the small cell. In contrast, the total exposure in a macro cell scenario is dominated by the uplink exposure. In order to minimise the total exposure, a balance must be sought between downlink and uplink exposure.

Conclusion

With the proposed method of combined UL [uplink] and DL [downlink] exposure assessment, a comparison was made between macro cell and small cell scenarios, with the latter tending to lower the total user exposure.

Therefore, not only the demands for improved data rates, capacities and coverage of the mobile network, but also a reduction of the total exposure could be achieved with the small cell deployment. The proposed method could be extended to the evaluation of the dose with different exposure durations due to the link connections. In a next step, the data can be evaluated in relation to measurement distances, in order to make a general statement about total exposure independent of specific measurement scenarios. Furthermore, the method should be extended towards 5G and indoor small cells.

https://ieeexplore.ieee.org/document/9784284

MOBILE PHONE CARRYING LOCATIONS AND RISK PERCEPTION OF MEN: A CROSS-SECTIONAL STUDY

Zeleke BM, Brzozek C, Bhatt CR, Abramson MJ, Freudenstein F, Croft RJ, Wiedemann PM, Benke G. PLoS One. 2022 Jun 7;17(6):e0269457. doi: 10.1371/journal.pone.0269457.

Abstract

Little was known about the relationship between carrying mobile phone handsets by men and their risk perception of radiofrequency-electromagnetic field (RF-EMF) exposure due to carrying handsets close to the body. This study aimed to determine where men usually carried their handsets and to assess the relationship to risk perception of RF-EMF. Participants

completed a self-administered questionnaire about mobile phone use, handset carrying locations, and levels of risk perception to RF-EMF. Data were analysed using linear regression models to examine if risk perception differed by mobile phone carrying location. The participants were 356 men, aged 18-72 years. They owned a mobile phone for 2-29 years, with over three quarters (78.7%) having a mobile phone for over 20 years. The most common locations that men kept their handsets when they were 'indoors' were: on a table/desk (54.0%) or in close contact with the body (34.7%). When outside, 54.0% of men kept the handset in the front trouser pocket. While making or receiving calls, 85.0% of men held their mobile phone handset against the head and 15.0% either used earphones or loudspeaker. Men who carried their handset in close contact with the body perceived higher risks from RF-EMF exposure compared to those who kept it away from the body ($p<0.01$). A substantial proportion of men carried their mobile phone handsets in close proximity to reproductive organs i.e. front pocket of trousers (46.5%). Men who kept their handset with the hand ($p < .05$), and those who placed it in the T-shirt pocket ($p < .05$), while the phone was not in use, were more likely to perceive health risks from their behaviour, compared to those who kept it away from the body. However, whether this indicates a causal relationship, remains open.

Excerpt

In the current study, one in every six men believed that carrying mobile phones would cause infertility. This may not be surprising since a third of the participants also reported feeling heating on body parts near where the mobile phone was carried. This may be worrisome in modern days since smartphones are more prone to heating human tissues in contact as there is a trend in moving toward lower specific absorption rate (SAR) and higher battery capacity smartphones due to their increased uses other than making/receiving calls [6]....

Given the ubiquity of mobile phone use and that the majority of men carried their mobile phones in close proximity to reproductive organs (e.g. testes), the relationship between resulting perceived RF-EMF exposures and associated health risks warrants further research.

Open access paper:
https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0269457

BLUETOOTH VERSUS NON-BLUETOOTH EARPHONES AND THEIR POTENTIAL HARMFUL EFFECT ON HEARING: A CROSS-SECTIONAL STUDY CONDUCTED AMONG UNDERGRADUATE MEDICAL STUDENTS, SAUDI ARABIA

Zeinab A. Abd-El.haleem, Madania M N. Idrees, Waqas Sami, Shamshad B.A. Loni, Hemmat H.G.Hareedy. International Journal of Early Childhood Special Education (INT-JECSE). 2022. 14(03): 3115.

Abstract

Background The use of Bluetooth and non- Bluetooth earphones is increasing worldwide. Improper use of these devices is associated with a higher risk for hearing loss. The objective of this study was to determine the effect of use of Bluetooth and non -Bluetooth earphones on hearing function and to determine whether the combined use of both types have more negative impact on hearing or not.

Methods A cross-sectional study was conducted on 42 adult female students in medical college, Majmaah University. It included a questionnaire to evaluate earphone listening habits and pure-tone audiometry to assess hearing function. The data was analyzed using ANOVA and Chi-square tests to fulfill the objectives of the study.

Results Around 85.7% of the students had hearing threshold ≥20 dB HL at one or more frequencies. Left ears were more affected than right ears. Hearing threshold > 40dB HL was observed in left ear. A significant higher difference was only observed between combined group and Bluetooth group at frequency of 250 Hz in left ear. No significant difference was observed between studied groups at other frequencies. Poorer hearing thresholds was observed in those who frequently used earphones.

Conclusion Main hearing thresholds were poor in earphone users which could be interpreted as earphones use may have negative impact on hearing. The combined use of both types of earphones did not show more negative impact on hearing threshold. It is essential to implement education programs in order to raise young people's awareness of proper earphone use and change their attitudes toward them.

Conclusion

Pure-tone audiometry showed poor hearing thresholds in those using earphones for more than 1 year. 85.7% of the students had hearing thresholds >20 dB HL at one or more frequencies. Mild hearing loss was observed in both right and left ears. Moderate hearing loss was observed in left ear only. On comparing the mean hearing thresholds of the three studied group, a higher hearing threshold was only observed between the combined and Bluetooth groups at frequency of 250 Hz in left ear. In right ear no difference was observed between the three studied groups at all frequencies. Thus, combined use of Bluetooth and non-Bluetooth earphones did not show more risk on hearing function in relation to either Bluetooth or non-Bluetooth alone.

Open access paper:

https://www.int-jecse.net/data-cms/articles/20220524061918pm380.pdf

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EVIDENCE OF THE RADIOFREQUENCY EXPOSURE ON THE ANTIOXIDANT STATUS POTENTIALLY CONTRIBUTING TO THE INFLAMMATORY RESPONSE AND DEMYELINATION IN RAT BRAIN

Sharma A, Shrivastava S, Singh A, Gupte SS, Rathore A, Reshi MS, Shukla S. Environ Toxicol Pharmacol. 2022 Jun 11:103903. doi: 10.1016/j.etap.2022.103903.

Highlights

- MWR produces a significant rise in lipid peroxidation and depletion of total antioxidant status.
- Chronic exposure of MWR alters the heme synthetic pathway.
- MWR exposure induces inflammatory response in the rats that may cause neural injury.
- Prolonged MWR exposure degenerated hippocampus, cerebellum and corpus callosum.
- Long term MWR exposure showed mitochondrial damage and demyelination.

Abstract
Present study exhibited the oxidative potential of microwave radiation (MWR) leading to the neurodegeneration in rats. Wistar rats were exposed at 2100MHz frequency for 4hours/day, 5days/week/3 months. Animals were exposed at an estimated specific absorption rate (0.453W/kg) and power density (8.237µW/m2). After exposure, the irradiated group was compared with control group. Results indicated that microwave exposure significantly increased the levels of serological triglycerides and cholesterol. Oxidative stress is observed through alteration of Glutathione homeostasis followed by Activated inflammatory response further confirmed by pro and anti- inflammatory cytokines in the exposed group. Histopathological assessments and electron microscopic observation confirmed a significant change in the myelination pattern and cellular organelles in the brain of exposed animals. Taking everything into account it can be concluded that chronic exposure of 2100-MHz frequency caused oxidative stress, which leads to neural damage and demyelination and may affect neural communication.
https://pubmed.ncbi.nlm.nih.gov/35700956/

Conclusion
In conclusion, our findings suggested that 2100 MHz frequency exposure (0.433, W/kg SAR) leads to an increase in free radicals due to compromised GSH homeostasis. It contributes to the poor defense capacity of the brain against reactive oxygen species that leads to a condition of oxidative stress. The oxidative stress modulates immune responses that further elicit neuronal cell death and demyelination. Thus, strengthening the statement that microwave radiation exposure is a "multi-hit" process of pathogenesis, including, oxidative stress, inflammatory activation, and demyelination contributed to the prevalence of neurodegenerative diseases.

EFFECTS OF 5.8 GHZ MICROWAVES ON TESTICULAR STRUCTURE AND FUNCTION IN RATS
Xue Y, Guo L, Lin J, Lai P, Rui G, Liu L, Huang R, Jing Y, Wang F, Ding G. Effects of 5.8 GHz Microwaves on Testicular Structure and Function in Rats. Biomed Res Int. 2022 Jun 6;2022:5182172. doi: 10.1155/2022/5182172.

Abstract
Objective: To investigate the effects of exposure to 5.8 GHz microwaves on testicular structure and function of male adult rats.

Methods: After 30 days of exposure, we evaluated sperm quality by determining sperm concentration and quantifying the number of abnormal sperm. Testicular morphology was investigated by hematoxylin-eosin (HE) staining. The levels of testosterone (T), follicle-stimulating hormone (FSH), luteinizing hormone (LH), glial cell line-derived neurotrophic factor (GDNF), stem cell factor (SCF), and transferrin (TRF) were determined by enzyme-linked immunosorbent assays (ELISAs). We also used western blotting to determine the levels of GDNF and SCF and apoptosis-related protein (caspase-3) in the testis.

Results: Compared with the sham group, there were no significant differences in terms of sperm count, sperm abnormality, and the levels of T, FSH, LH, GDNF, SCF, and caspase-3 in the microwave group.

Conclusion: Under the experimental conditions, 5.8 GHz microwave exposure has no obvious effect on testicular structure and function of rats.
Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9192205/

TRANSGENERATIONAL CHANGES IN DAPHNIA MAGNA UNDER RADIO FREQUENCY RADIATION IN THE JUVENILE AND PUBERTY PERIOD

Sarapultseva EI, Uskalova DV, Ustenko KV, Tikhonov VN, Ivanov IA, Tikhonov AV. Transgenerational changes in Daphnia magna under radio frequency radiation in the juvenile and puberty period. Int J Radiat Biol. 2022 Jun 8:1-31. doi: 10.1080/09553002.2022.2087928.

Abstract

Purpose To analyze the results of direct and transgenerational effects of radio frequency electromagnetic fields (RF-EMF) on the model organism of crustaceans Daphnia magna.

Materials and Methods D. magna were chronically exposed at 900 GHz EMF with an energy flux density (EFD) of about 1 mW/cm2 in the juvenile and pubertal periods of their ontogenesis. The cytotoxicity of exposure as well as survival, fertility and teratogenic effect of directly exposed daphnids and their progeny across three generations were analyzed.

Results and Conclusions The results of our study show that exposure of RF-EMF at juvenile period can significantly affect the fertility and size of irradiated daphnids and their offspring of the first generation. The decrease in fertility may be associated with a cytotoxic effect on the cells of irradiated animals. The reduction in the size of the spike and the body of individuals is an indicator of the negative impact of radiation on the protective strategy of the crustacean population. The reproductive process is restored by the second generation. The results of our study provide further insights into the possible mechanisms underlying the in vivo effects of RF-EMF. https://pubmed.ncbi.nlm.nih.gov/35675553/

THE EFFECT OF ELECTROMAGNETIC RADIATION TRANSMITTED FROM ROUTERS ON ANTIBIOTIC SUSCEPTIBILITY OF BACTERIAL PATHOGENS

Pegios, A., Kavvadas, D., Zarras, K., Mpani, K., Soukiouroglou, P., Charalampidou, S., Vagdatli, E., Papamitsou, T. (2022). 'The Effect of Electromagnetic Radiation Transmitted from Routers on Antibiotic Susceptibility of Bacterial Pathogens', Journal of Biomedical Physics and Engineering. Available Online from 22 June 2022.

Abstract

Background: Electromagnetic non-ionizing radiation has both thermal and non-thermal outcomes on biological systems, such as humans, animals, and bacteria.

Objective: This study aimed to investigate the effect of non-ionizing radiofrequency radiation, emitted by Wi-Fi routers, on bacterial strains and the modification of their susceptibility to modern antibiotics.

Material and Methods: In this case-control paired study, four bacteria were selected, and one colony from each bacterial strain was exposed to Wi-Fi radiation forming the exposure group. Another set of colonies was not exposed to Wi-Fi radiation, forming the control group.

Eight different antibiotic disks were set on the bacterial plates, and the inhibition zone was measured every 3 h for each colony.

Results: Electromagnetic radiation affects bacterial colonies and their susceptibility to antibiotics. Analysis revealed statistically significant differences, correlated with the bacterial strain, the antibiotic agent, and the time of the exposure, in the inhibition zones, mostly after 6 and 24 h (p-value < 0.05).

Conclusion: A correlation was observed between antibiotic susceptibility and non-ionizing radiofrequency exposure. Studying the effects of radiofrequency radiation on prokaryotic organisms could clarify more complicated cell structures and organisms, such as eukaryotic. Further experiments, in vitro and in vivo, could provide more information about these outcomes and cause experts to discuss the current guidelines of exposure limits.
Open access paper: https://jbpe.sums.ac.ir/article_48472.html

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LABEL-FREE STUDY OF THE GLOBAL CELL BEHAVIOR DURING EXPOSURE TO ENVIRONMENTAL RADIOFREQUENCY FIELDS IN THE PRESENCE OR ABSENCE OF PRO-APOPTOTIC OR PRO-AUTOPHAGIC TREATMENTS

Joushomme A, Garenne A, Dufossée M, Renom R, Ruigrok HJ, Chappe YL, Canovi A, Patrignoni L, Hurtier A, Poulletier de Gannes F, Lagroye I, Lévêque P, Lewis N, Priault M, Arnaud-Cormos D, Percherancier Y. Label-Free Study of the Global Cell Behavior during Exposure to Environmental Radiofrequency Fields in the Presence or Absence of Pro-Apoptotic or Pro-Autophagic Treatments. Int J Mol Sci. 2022 Jan 8;23(2):658. doi: 10.3390/ijms23020658.

Abstract

It remains controversial whether exposure to environmental radiofrequency signals (RF) impacts cell status or response to cellular stress such as apoptosis or autophagy. We used two label-free techniques, cellular impedancemetry and Digital Holographic Microscopy (DHM), to assess the overall cellular response during RF exposure alone, or during co-exposure to RF and chemical treatments known to induce either apoptosis or autophagy. Two human cell lines (SH-SY5Y and HCT116) and two cultures of primary rat cortex cells (astrocytes and co-culture of neurons and glial cells) were exposed to RF using an 1800 MHz carrier wave modulated with various environmental signals (GSM: Global System for Mobile Communications, 2G signal), UMTS (Universal Mobile Telecommunications System, 3G signal), LTE (Long-Term Evolution, 4G signal, and Wi-Fi) or unmodulated RF (continuous wave, CW). The specific absorption rates (S.A.R.) used were 1.5 and 6 W/kg during DHM experiments and ranged from 5 to 24 W/kg during the recording of cellular impedance. Cells were continuously exposed for three to five consecutive days while the temporal phenotypic signature of cells behavior was recorded at constant temperature. Statistical analysis of the results does not indicate that RF-EMF exposure impacted the global behavior of healthy, apoptotic, or autophagic cells, even at S.A.R. levels higher than the guidelines, provided that the temperature was kept constant.
Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8776001/

MILLIMETER WAVES ALTER DNA SECONDARY STRUCTURES AND MODULATE THE TRANSCRIPTOME IN HUMAN FIBROBLASTS

Lawler NB, Evans CW, Romanenko S, Chaudhari N, Fear M, Wood F, Smith NM, Wallace VP, Swaminathan Iyer K. Millimeter waves alter DNA secondary structures and modulate the transcriptome in human fibroblasts. Biomed Opt Express. 2022 Apr 28;13(5):3131-3144. doi: 10.1364/BOE.458478.

Abstract

As millimetre wave (MMW) frequencies of the electromagnetic spectrum are increasingly adopted in modern technologies such as mobile communications and networking, characterising the biological effects is critical in determining safe exposure levels. We study the exposure of primary human dermal fibroblasts to MMWs, finding MMWs trigger genomic and transcriptomic alterations. In particular, repeated 60 GHz, 2.6 mW cm-2, 46.8 J cm-2 d-1 MMW doses induce a unique physiological response after 2 and 4 days exposure. We show that high dose MMWs induce simultaneous non-thermal alterations to the transcriptome and DNA structural dynamics, including formation of G-quadruplex and i-motif secondary structures, but not DNA damage.

Excerpt

In conclusion, our findings demonstrate that high dose MMWs can induce characteristic transcriptomic and genomic modifications in primary human fibroblasts that are not associated with a typical cellular thermal response. We show that MMW-induced changes at the transcriptome level are distinct from a traditional cytokine-induced transition, and that they may be associated with alterations in DNA structural dynamics. These changes represent unique interactions of MMWs with biological material and illustrate the importance of both power density and dose when determining safety margins for longer periods.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9203081/

EFFECTS OF INTERMEDIATE FREQUENCY ELECTROMAGNETIC FIELDS: A REVIEW OF ANIMAL STUDIES

Lee Hae-June, Jin Hee, Ahn Young Hwan, Kim Nam, Pack Jeong Ki, Choi Hyung-Do, Lee Yun-Sil. Effects of intermediate frequency electromagnetic fields: a review of animal studies. International Journal of Radiation Biology. 2022. doi: 10.1080/09553002.2022.2094016

Abstract

Many novel devices such as induction cookers or wireless power transfer produce electromagnetic fields (EMFs) in the intermediate frequency (IF) range (300 Hz to 10 MHz) and it is very meaningful for summarizing the bioeffects of IF-EMF research, particularly animal studies. This review takes into account experimental studies that used murine models to study the health effects of exposure to IF-EMF. The analyses included here use data available in the literature published from January 1988 to August 2021 including the animal studies about general adverse effects, tumorigenic effects, and effects on developmental stages. The studies that linked IF- EMF exposure during pregnancy or neonatal stage to behavioral and cognition changes were included.

Additionally, this review also covers the effects of IF-EMF on gene expression patterns in the brain, behavior patterns associated with learning and memory, and immune function.

Excerpt

The main sources of IF-EMF can be divided into the following areas.

- **Industry:** dielectric heater sealers, induction and plasma heaters, broadcast and telecommunication transmitters
- **General public:** induction cookers, proximity readers, electronic article surveillance systems and other anti-theft devices, computer monitors, and TV sets
- **Hospitals:** MRI systems, electromagnetic nerve stimulators, electrosurgical instruments, and other medical devices
- **Defense:** submarine communication transmitters and high frequency (HF) transmitters.

Conclusion

As the use of IF-EMF-based devices such as induction cookers and wireless power transfer increases, it is meaningful to comprehensively summarize the biological effects of IF-EMF studies conducted so far, especially animal studies. We reviewed a total of 38 experimental studies published from databases EMF Portal and PubMed between January 1988 to August 2021 that used rats or mice to investigate the effects of IF-EMF on prolonged exposure, developmental stages, tumorigenicity, effects on sperm fertility, and other effects that linked IF-EMF exposure during pregnancy or neonatal stage to behavioral and cognition changes. In addition, studies on gene expression in the brain, learning and memory behaviors, and immune functions by IF-EMFs have also been evaluated. Even though most studies have reported that IF-EMFs do not induce any adverse effects, some studies have linked harmful effects on early development in mice. The adverse effects on neutrophil count, cytokines, and the concentrations of testosterone and progesterone, and the alteration of mRNA or protein expression levels in the brain, were also reported. However, the health effects of IF-EMF exposure were not independently reproduced and were not dependent on the degree of IF-EMF exposure. Therefore, we concluded that IF-EMF exposure within ICNRP limits (ICNRP reference levels: 27 μT for the general public and 100 μT for occupational exposure) did not produce any harmful effects on animals. Of course, more research needs to be done using the latest biomedical tools, however, a comprehensive review of IF-EMF studies, especially animal studies, will provide a valuable basis for further risk analysis of IF-EMF in humans.
https://www.tandfonline.com/doi/full/10.1080/09553002.2022.2094016

GEOMAGNETIC DISTURBANCES REDUCE HEART RATE VARIABILITY IN THE NORMATIVE AGING STUDY

Carolina L. Zilli Vieira, Kelly Chen, Eric Garshick, Man Liu, Pantel Vokonas, Petter Ljungman, Joel Schwartz, Petros Koutrakis. Geomagnetic disturbances reduce heart rate variability in the Normative Aging Study. Science of The Total Environment. Volume 839. 15 September 2022. 156235. doi: 10.1016/j.scitotenv.2022.156235.

Highlights

- Intense geomagnetic activity up to 24 h reduced heart rate variability (HRV).
- Patients with coronary heart diseases presented higher risk.
- The associations remained similar after the adjustments for air pollutant exposures.
- Geomagnetic activity may account for temporal HRV-related cardiovascular outcomes.

Abstract

Background Solar and geomagnetic activity (GA) have been linked to increased cardiovascular (CVD) events. We hypothesize that heart rate variability (HRV) may be the biological mechanism between increased CVD risk and intense geomagnetic disturbances (GMD).

Methods To evaluate the impact of GA and intense GMD on HRV in 809 elderly men [age mean 74.5 (SD = 6.8)] enrolled in the Normative Aging Study (Greater Boston Area), we performed repeated-measures using mixed- effects regression models. We evaluated two HRV outcomes: the square root of the mean squared differences of successive normal-to-normal intervals (r-MSSD) and the standard deviation of normal-to-normal heartbeat intervals (SDNN) in milliseconds (ms). We also compared the associations between Kp and HRV in patients with and without comorbidities such as diabetes and coronary heart diseases (CHD). We used data on global planetary K-Index (Kp) from middle latitudes as a GA and GMD (>75th Kp) parameters from the National Oceanic and Atmospheric Agency's Space Weather Prediction Center.

Results We found a near immediate effect of continuous and higher Kp on reduced HRV for exposures up to 24 h prior to electrocardiogram recording. A 75th percentile increase in 15-hour Kp prior the examination was associated with a −14.7 ms change in r-MSSD (95 CI: −23.1, −6.3, p-value = 0.0007) and a −8.2 ms change in SDNN (95 CI: −13.9, −2.5, p-value = 0.006). The associations remained similar after adjusting the models for air pollutants over the exposure window prior to the event. In periods of intense GMD, the associations were stronger in patients with CHD and non-diabetes.

Conclusions This is the first study to demonstrate the potential adverse effects of geomagnetic activity on reduced heart rate variability in a large epidemiologic cohort over an extended period, which may have important clinical implications among different populations.

Conclusions

Our findings showed a significant impact of GA and intense GMD on the reduction in HRV up to 24 h prior to the electrocardiogram in elderly individuals. The associations remained even after adjusting for air pollutants. In periods of intense GMD, the reduction of HRV was even stronger in patients with CHD and no diabetes. This exposure nexus could have important clinical implications for cardiac health and preventative strategies, as HRV is a predictor of CVD morbidity and mortality caused by the dysregulation of sympathetic and/or parasympathetic activity. Future studies may investigate differential susceptibility and related biological mechanisms based on location, age, and other pre-existing comorbidities in different populations.

Open access paper (until July 21, 2022): https://bit.ly/GMDhrv

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SOLAR AND GEOMAGNETIC ACTIVITY REDUCES PULMONARY FUNCTION AND ENHANCES PARTICULATE POLLUTION EFFECTS

Kritika Anand, Carolina L.Z. Vieira, Eric Garshick, Veronica Wang, Annelise Blomberg, Diane R. Gold, Joel Schwartz, Pantel Vokonas, Petros Koutrakis. Solar and geomagnetic activity reduces pulmonary function and enhances particulate pollution effects. Science of The Total Environment. 2022. 156434. doi: 10.1016/j.scitotenv.2022.156434.

Abstract

Background Increased solar and geomagnetic activity (SGA) may alter sympathetic nervous system activity, reduce antioxidant activity, and modulate physiochemical processes that contribute to atmospheric aerosols, all which may reduce pulmonary function.

Objectives Investigate associations between forced expiratory volume at 1 s (FEV1) and forced vital capacity (FVC) with SGA, and assess whether SGA enhances adverse effects of particulate pollution, black carbon (BC) and particulate matter ≤2.5 μm in diameter (PM2.5).

Methods We conducted a repeated measures analysis in 726 Normative Aging Study participants (Boston, Massachusetts, USA) between 2000 and 2017, using interplanetary magnetic field (IMF), planetary K index (Kp), and sunspot number (SSN) as SGA measures. Linear mixed effects models were used to assess exposure moving averages up to 28 days for both SGA and pollution.

Results Increases in IMF, Kp Index and SSN from the day of the pulmonary function test averaged through day 28 of were associated with a significant decrement in FEV1 and FVC, after adjusting for potential confounders. There were greater effects for longer moving averages and enhanced effects of PM2.5 and BC on FEV1 and FVC with increased SGA. For example, for each inter-quartile increase (4.55 μg/m3) in average PM2.5 28 days before testing, low IMF (10th percentile: 3.2 nT) was associated with a −21.4 ml (95 % CI: −60.8, 18.1) and −7.1 ml (95 % CI: −37.7, 23·4) decrease in FVC and FEV1, respectively; high IMF (90th percentile: 9.0 nT) was associated with a−120.7 ml (95 % CI:-166.5, −74.9) and −78.6 ml (95 % CI: −114.3, −42·8) decrease in FVC and FEV1, respectively.

Discussion Increased periods of solar and geomagnetic activity may directly contribute to impaired lung function and also enhance effects of PM2.5 and BC. Since exposure to solar activity is ubiquitous, stricter measures in reducing air pollution exposures are warranted, particularly in elderly populations.

Open access paper (until July 30, 2022): https://authors.elsevier.com/c/1fDlOB8cculns

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Recurrent ancient geomagnetic field anomalies shed light on future evolution of the South Atlantic Anomaly

Andreas Nilsson, Neil Suttie, Joseph S. Stoner, Raimund Muscheler. Recurrent ancient geomagnetic field anomalies shed light on future evolution of the South Atlantic Anomaly. PNAS. 2022. 119 (24) e2200749119. doi: 10.1073/pnas.2200749119.

Significance

Earth's magnetic field, which is generated through convection in the liquid iron–rich outer core, acts as a shield against harmful particle radiation. During the past two centuries, the field strength has decreased rapidly as an area of weak field has expanded over the South

Atlantic Ocean. The decreased shielding effect of the magnetic field in this area has important implications for low Earth-orbiting satellites and space travel. Using archeological and geological records, we have reconstructed the variations of Earth's magnetic field over the past 9,000 y. We find evidence for recurrent magnetic field anomalies, similar to the present-day South Atlantic Anomaly, which provides insights into underlying geodynamo processes that may help predict the future development of Earth's magnetic field.

Abstract

The strength of the geomagnetic field has decreased rapidly over the past two centuries, coinciding with an increasing field asymmetry due to the growth of the South Atlantic Anomaly. The underlying processes causing the decrease are debated, which has led to speculation that the field is about to reverse. Here, we present a geomagnetic field model based on indirect observations over the past 9,000 y and identify potential ancient analogs. The model is constructed using a probabilistic approach that addresses problems with age uncertainties and smoothing of sedimentary data that have hampered previous attempts. We find evidence for recurrent hemispherical field asymmetries, related to quasiperiodic millennial-scale variations in the dipole moment. Our reconstruction indicates that minima in the dipole moment tend to coincide with geomagnetic field anomalies, similar to the South Atlantic Anomaly. We propose that the period around 600 BCE, characterized by a strongly asymmetric field, could provide an analog to the present-day field. The analogy implies that the South Atlantic Anomaly will likely disappear in next few hundred years, accompanied by a return to a more symmetric field configuration and possibly, a strengthening of the axial dipole field. https://www.pnas.org/doi/full/10.1073/pnas.2200749119

MYTHS IN MAGNETOSENSATION

Simon Nimpf, David A. Keays. Myths in magnetosensation. 25(6); 104454. May 23, 2022. doi: 10.1016/j.isci.2022.104454.

Summary

The ability to detect magnetic fields is a sensory modality that is used by many animals to navigate. While first postulated in the 1800s, for decades, it was considered a biological myth. A series of elegant behavioral experiments in the 1960s and 1970s showed conclusively that the sense is real; however, the underlying mechanism(s) remained unresolved. Consequently, this has given rise to a series of beliefs that are critically analyzed in this manuscript. We address six assertions: (1) Magnetoreception does not exist; (2) It has to be magnetite; (3) Birds have a conserved six loci magnetic sense system in their upper beak; (4) It has to be cryptochrome; (5) MagR is a protein biocompass; and (6) The electromagnetic induction hypothesis is dead. In advancing counter-arguments for these beliefs, we hope to stimulate debate, new ideas, and the design of well- controlled experiments that can aid our understanding of this fascinating biological phenomenon. Open access paper: https://www.cell.com/iscience/fulltext/S2589-0042(22)00725-8

A CRITICAL ANALYSIS OF THE MOBI-KIDS STUDY OF WIRELESS PHONE USE IN CHILDHOOD AND ADOLESCENCE AND BRAIN TUMOR RISK

Lennart Hardell, Joel M. Moskowitz. A critical analysis of the MOBI-Kids study of wireless phone use in childhood and adolescence and brain tumor risk. Reviews on Environmental Health, May 5, 2022. https://doi.org/10.1515/reveh-2022-0040.

Abstract

The MOBI-Kids case-control study on wireless phone use and brain tumor risk in childhood and adolescence included the age group 10–24 years diagnosed between 2010 and 2015. Overall no increased risk was found although for brain tumors in the temporal region an increased risk was found in the age groups 10–14 and 20– 24 years. Most odds ratios (ORs) in MOBI-Kids were <1.0, some statistically significant, suggestive of a preventive effect from RF radiation; however, this is in contrast to current knowledge about radiofrequency (RF) carcinogenesis. The MOBI-Kids results are not biologically plausible and indicate that the study was flawed due to methodological problems. For example, not all brain tumor cases were included since central localization was excluded. Instead, all brain tumor cases should have been included regardless of histopathology and anatomical localization. Only surgical controls with appendicitis were used instead of population-based controls from the same geographical area as for the cases. In fact, increased incidence of appendicitis has been postulated to be associated with RF radiation which makes selection of control group in MOBI-Kids questionable. Start of wireless phone use up to 10 years before diagnosis was in some analyses included in the unexposed group. Thus, any important results demonstrating late carcinogenesis, a promoter effect, have been omitted from analysis and may underestimate true risks. Linear trend was in some analyses statistically significant in the calculation of RF-specific energy and extremely low frequency (ELF)-induced current in the center of gravity of the tumor.

Additional case-case analysis should have been performed. The data from this study should be reanalyzed using unconditional regression analysis adjusted for potential confounding factors to increase statistical power. Then all responding cases and controls could be included in the analyses. In sum, we believe the results as reported in this paper seem uninterpretable and should be dismissed.

Summary

- In our opinion, the results as reported in the MOBI-Kids paper seem uninterpretable and should be dismissed.
- All brain tumor cases should have been included regardless of histopathology and anatomical localization.
- Only surgical controls with suspected appendicitis were used. Yet, increased incidence of appendicitis has been postulated to be associated with RF radiation.
- Start of wireless phone use up to 10 years before diagnosis was in some analyses included in the unexposed group. This would bias the ORs towards unity.
- The results indicate an increased risk for tumors in the temporal brain region in spite of methodological issues based on low numbers in several categories.

- Linear trend was in some analyses statistically significant in the calculation of RF-specific energy and ELF- induced current in the center of gravity of the tumor. Additional case-case analysis should have been performed.
- The data from this study should be reanalyzed using unconditional regression analysis adjusted for potential confounding factors to increase the statistical power.

Finally, it is unfortunate that after such a major investment of resources that little can be learned at this time from the MOBI-Kids study about the risk of brain tumors from wireless phone use in young people. Since the study addresses an issue critical to public health and the majority of the funding was from the European Commission, the MOBI-Kids data set should be publicly archived making it available to the scientific community to enable the data to be re-analyzed using different assumptions and methods.

Open access paper: https://www.degruyter.com/document/doi/10.1515/reveh-2022-0040/html

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GENOTOXIC EFFECTS OF ELECTROMAGNETIC FIELD RADIATIONS FROM MOBILE PHONES (REVIEW)

Ganesh Chandra Jagetia. Genotoxic effects of electromagnetic field radiations from mobile phones. Environmental Research. 2022. 113321. doi: 10.1016/j.envres.2022.113321.

Highlights

- The exposure to electromagnetic field radiation has increased tremendously from manmade electronic gadgets in addition to natural sources.
- A few studies on mobile phone exposure indicated that it does not cause harmful effects.
- The studies indicated a positive correlation between mobile phone use and genotoxic effects that outnumber the negative effect.
- Electromagnetic field radiations increase reactive oxygen species formation that causes mutagenic and genotoxic effects leading to cancer.

Abstract

The use of wireless communication technology in mobile phones has revolutionized modern telecommunication and mobile phones have become so popular that their number exceeds the global population. Electromagnetic field radiations (EMR) are an integral part of wireless technology, which are emitted by mobile phones, mobile towers, electric power stations, transmission lines, radars, microwave ovens, television sets, refrigerators, diagnostic/therapeutic and other electronic devices. The manmade EMR sources have added to the existing burden of natural EMR human exposure arising from the Sun, cosmos, atmospheric discharges, and thunderstorms. EMR including radiofrequency waves (RF) and extremely low frequency radiation (ELF) has generated great interest as their human exposure causes headache, fatigue, tinnitus, concentration problems, depression, memory loss, skin irritation, sleep disorders, nausea, cardiovascular effects, chest pain, immunity and hormonal disorders as the short-term effects and cancer as the late effect. The review has been written by collecting the information using various search engines including google scholar, PubMed SciFinder, Science direct, EMF-portal, saferemr, and other websites on the internet and its main focus is on the mutagenic and genotoxic effects of EMR in humans and mammals. Numerous investigations revealed that exposure in the range of 0–300 GHz EMR is harmless as this did not increase micronuclei and chromosome aberrations. On the

contrary, several other studies have demonstrated that exposure to EMR increases the frequency of micronuclei, chromosome aberrations, DNA adducts, DNA single and double strand breaks at the molecular level in vitro and in vivo. The EMR exposure induces reactive oxygen species and changes the fidelity of genes involved in signal transduction, cytoskeleton formation, and cellular metabolism.

Excerpts

Table 1 lists 75 (23 ELF/IF, 52 RF) studies that did not find significant genotoxic effects. Table 2 lists 145 (47 ELF/IF, 98 RF) studies that reported significant genotoxic effects. Conclusions
The electromagnetic radiations especially in the radiofrequency range are long wavelength radiation and they have a wide application in wireless communication. Human exposure to EMF-RF-ELF is from electrical transmission lines, mobile signal transmission towers, mobile phones, microwaves and various electronic gadgets which are in daily use. A phenomenal rise in the subscription of mobile phones which continues unabated has drastically increased the exposure to EMF-RF-ELF of children and adults equally. Various agencies worldwide have also raised concern about the ill effects of these radiations. Investigations reporting that EMF- RF-ELF exposures are are genotoxic outnumber the reports that the EMF-RF-ELF exposure are not harmful to the human population, Various preclinical models report the genotoxic effect of EMF-RF-ELF in the form of chromosome condensation, various types of chromosome aberrations, micronuclei formation, sister chromatid exchanges, DNA base damages, DNA adduct formation, DNA SSBs and DNA DSBs. The EMF-RF-ELF triggered the formation of ROS, which seem to be responsible for all the genotoxic and mutagenic effects of EMF-RF-ELF.
EMF-RF-ELF also reduces antioxidant status by alleviating GSH, catalase, SOD, GST, GPx and increasing lipid peroxidation. At the molecular level EMF-RF-ELF stimulates the activation NF-κB, TNF-α, HSP 70, p53, Chk-2, p38, LC3-II, pAMPK, PARP, Bax/Bcl-2 ratio, DNA-PKcs, RAD9B, BM11, cytochrome c release and cleaved caspase- 3 and subsequently downmodulates p21, p62, p-mTOR, GADD45α, XRCC1, XRCC4, Ku80 (XRCC5), Ku70 (XRCC6), and LIG4, caspase3 and Bcl2 which are involved in numerous cellular processes. The repeated EMF-RF-ELF exposures exert a negative effect on human health and cause mutagenesis and cancer in humans. It will be prudent to follow ALARA (as low as reasonably achievable) principle to minimize the adverse effect on humans. https://pubmed.ncbi.nlm.nih.gov/35508219/

ANALYSIS OF ICNIRP 2020 BASIC RESTRICTIONS FOR LOCALIZED RADIOFREQUENCY EXPOSURE IN THE FREQUENCY RANGE ABOVE 6 GHZ

Eric Lemay, Gregory B Gajda, Gregory W McGarr, Mykola Zhuk, Jonathan Paradis. Analysis of ICNIRP 2020 Basic Restrictions for Localized Radiofrequency Exposure in the Frequency Range Above 6 GHz. Health Phys. 2022 May 21. doi: 10.1097/HP.0000000000001581.

Abstract

ICNIRP 2020 guidelines have defined a practical temperature elevation threshold for human health effects, namely the operational adverse health effect threshold that forms the basis of the absorbed power and energy density basic restrictions. These basic restrictions for localized exposures at frequencies above 6 GHz were evaluated by comparing numerically computed temperature rise against the target temperature rise of 2.5 oC, which is the operational adverse health effect threshold divided by the occupational safety factor of 2. The numerical model employs the maximum absorbed power and energy density levels allowed by the occupational basic restriction for both pulsed and continuous wave exposures.

These analyses were performed considering 3- and 4-tissue layer models and a variety of beam diameters, frequencies, and exposure durations. The smallest beam diameters were based on a study of theoretically achievable beam widths from half-wave resonant dipoles and show the impact of the averaging area on the computed temperature elevation. The results demonstrated that ICNIRP's assumed occupational safety factors in the frequency range above 6 GHz were not sufficiently maintained for all exposure scenarios and particularly for short pulse exposures at frequencies of 30 GHz or higher with small beam diameters. Worst-case tissue temperature elevations were estimated to be as much as 3.6 times higher than ICNIRP's target temperature increases. Consequently, the authors suggest a small modification in the application of the ICNIRP 2020 localized basic restrictions, thereby limiting the worst-case tissue temperature increases to 1.4 times the target value.

Conclusion

Numerical computations of the SAR distribution and resulting temperature rise in models of superficial tissue at levels allowed by the ICNIRP (2020) BRs for frequencies above 6 GHz were carried out to investigate the safety factors from the assumed OAHET thermal thresholds inherent in the BRs.

The results showed that for a range of beam sizes, pulse durations, and carrier frequencies, the safety factors are reduced from their assumed values of 2 times below an OAHET temperature rise of 5 oC for the occupationally exposed. The lowest safety factors (the worst case was 0.56, resulting in a temperature rise of 1.8 times the OAHET) occurred for single pulses with the smallest assumed spot size of FWHM = 0.005 m (or an assumed unperturbed power density beam diameter of 0.0063 m) for short durations (td < 1 s) at 200 GHz.

Examinations of SAR distributions from half-wave resonant dipoles (Appendix) led to the decision to set a lower value of FWHM = 0.005 m for frequencies of 30 GHz and beyond. While it may be argued that current mobile applications may not deliver such small SAR distributions, there exists the theoretical possibility that even smaller spots sizes can be generated at the higher millimeter-wave frequencies covered in the ICNIRP (2020) guideline.

Safety factors for CW exposures (td > 360 s) were generally higher than for a single pulse, with the worst-case (a safety factor of 1.46 as opposed to the assumed value of 2) again occurring for the smallest spot size.

Despite the low worst-case safety factors and high resulting temperature rises, CEM43 calculations suggest that even minor damage to the skin is unlikely at the current BR levels in ICNIRP (2020). The small beam diameters at which the lowest safety factors occur would suggest that maintaining the beam on the skin for a length of time necessary to induce even minor damage would be practically impossible, especially given that under such conditions, exposed individuals would likely remove the affected tissue away from the RF heat source in response to the sensation of warmth and/or heat pain before tissue damage could occur.

Mitigation of the low safety factors that occurred for the smallest beam diameters can be accomplished by changing the 1 cm2 spatial averaging 0 cm2 (essentially the spatial peak of the beam). If this modification to the local BRs is applied, the associated maximum (worst-case) tissue temperature rise is ≈ 3.5 oC for exposures at the occupational BR (≈ 0.7 oC for

general public BR). This modification to the BR rules is easy to implement and would allow use of the ICNIRP (2020) AED formulae and APD limits for localized exposures above 6 GHz to 300 GHz to remain unchanged.

Open access paper:
https://journals.lww.com/healthphysics/Fulltext/9900/Analysis_of_ICNIRP_2020_Basic_Restrictions_for.15.aspx

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WHY ELECTROHYPERSENSITIVITY AND RELATED SYMPTOMS ARE CAUSED BY NON-IONIZING MAN-MADE ELECTROMAGNETIC FIELDS: AN OVERVIEW AND MEDICAL ASSESSMENT

Dominique Belpomme, Philippe Irigaray. Why electrohypersensitivity and related symptoms are caused by non- ionizing man-made electromagnetic fields: An overview and medical assessment. Environmental Research. May 7, 2022, 113374. doi: 10.1016/j.envres.2022.113374.

Highlights

- Electrohypersensitivity is caused by electromagnetic fields.
- Electrohypersensitivity is a neurological disorder with inflammation, oxidative stress, blood brain barrier opening and neurotransmitter abnormalities.
- Electrohypersensitivity must be defined by the decrease of brain electromagnetic fields tolerance threshold.

Abstract

Much of the controversy over the cause of electrohypersensitivity (EHS) lies in the absence of recognized clinical and biological criteria for a widely accepted diagnosis. However, there are presently sufficient data for EHS to be acknowledged as a distinctly well-defined and objectively characterized neurologic pathological disorder.

Because we have shown that 1) EHS is frequently associated with multiple chemical sensitivity (MCS) in EHS patients, and 2) that both individualized disorders share a common pathophysiological mechanism for symptom occurrence; it appears that EHS and MCS can be identified as a unique neurologic syndrome, regardless its causal origin. In this overview we distinguish the etiology of EHS itself from the environmental causes that trigger pathophysiological changes and clinical symptoms after EHS has occurred. Contrary to present scientifically unfounded claims, we indubitably refute the hypothesis of a nocebo effect to explain the genesis of EHS and its presentation. We as well refute the erroneous concept that EHS could be reduced to a vague and unproven “functional impairment”. To the contrary, we show here there are objective pathophysiological changes and health effects induced by electromagnetic field (EMF) exposure in EHS patients and most of all in healthy subjects, meaning that excessive non-thermal anthropogenic EMFs are strongly noxious for health. In this overview and medical assessment we focus on the effects of extremely low frequencies, wireless communications radio frequencies and microwaves EMF. We discuss how to better define and characterize EHS. Taken into consideration the WHO proposed causality criteria, we show that EHS is in fact causally associated with increased exposure to man-made EMF, and in some cases to marketed environmental chemicals. We therefore appeal to all governments and international health institutions, particularly the WHO, to

urgently consider the growing EHS-associated pandemic plague, and to acknowledge EHS as a new real EMF causally- related pathology. https://pubmed.ncbi.nlm.nih.gov/35537497/

AN IDIOGRAPHIC APPROACH TO IDIOPATHIC ENVIRONMENTAL INTOLERANCE ATTRIBUTED TO ELECTROMAGNETIC FIELDS (IEI- EMF) PART II. ECOLOGICAL MOMENTARY ASSESSMENT OF THREE INDIVIDUALS WITH SEVERE IEI-EMF

Zsuzsanna Dömötör, Gábor Ruzsa, György Thuróczy, Péter P Necz, Steven Nordin, Ferenc Köteles, Renáta Szemerszky. An idiographic approach to Idiopathic Environmental Intolerance attributed to Electromagnetic Fields (IEI-EMF) Part II. Ecological momentary assessment of three individuals with severe IEI-EMF. Heliyon. 2022 May 14;8(5):e09421. doi: 10.1016/j.heliyon.2022.e09421.

Abstract

IEI-EMF refers to a self-reported sensitivity characterized by attribution of non-specific physical symptoms to exposure to weak EMFs. The majority of empirical results do not support the existence of a causal relationship between EMF and IEI-EMF. However, this conclusion was drawn from environmental and experimental studies that are not without methodological limitations. In the current study, as part of a complex biopsychosocial approach, an ecological momentary assessment (EMA) protocol was applied for the investigation of the temporal relationship between actual radio frequency (RF) EMF exposure and IEI-EMF, at the individual level. Continuous measurement of autonomic variables by holter electrocardiogram (ECG) monitors and the ambient RF EMF by personal dosimeters, as well as repeated (8/day) paper-and-pencil assessments of momentary internal states (symptoms, mood, perceived EMF intensity) and situational factors was conducted for 21 days with the participation of three individuals with severe IEI-EMF. Temporal relationships were examined by time series analyses. For two participants, the results did not support the association between the suspected EMF frequency range(s) and symptom reports. Nevertheless, the results revealed a reverse association with respect to another frequency range (GSM900 downlink), which contradicts the IEI-EMF condition. Autonomic activation related findings were inconsistent. For the third participant, the claimed association was partly supported, both for symptom reports and autonomic reactions (UMTS downlink, total RF; RMS values). The findings of this study suggest that IEI-EMF does not have a unitary aetiology. For certain individuals, a biophysical background cannot be excluded, whereas no such underlying factor appears to be at work for others. EMA is a useful method for the investigation of the aetiology of IEI-EMF.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9123209/

MICROWAVE EMISSIONS AND THE PROBLEM OF MODERN VIRAL DISEASES

S V Avakyan, L A Baranova. Microwave Emissions and the Problem of Modern Viral Diseases. Her Russ Acad Sci. 2022;92(2):177-187. doi: 10.1134/S1019331622020058.

Abstract

The results of a study on the mechanisms of the influence of an increased level of microwave radiation on the growth of infectious, primarily viral, diseases in the environment are presented. This is the radiation of the earth's ionosphere, which reached its maximum in the late 1980s-early 2000s, following an increase in the level of solar activity since the 17th century. Over the past 30 years, the anthropogenic electromagnetic background has

increased 100 times due to the development of cellular mobile communications and computerization. The predicted interaction of natural and anthropogenic sources of microwaves sharply increases their negative impact on the ecological situation. Of particular concern is the active spread in recent years of the new 5G communication standard; in the future, it is the development of the most dangerous millimeter range in our country. Energy from the environment in the microwave range can cause "unexpected behavior" in the DNA of viruses. Clarifications to the recommendations of experts on the protection of the population with the help of electromagnetic shielding, obtained in the framework of supramolecular physics of the environment, are proposed.

Excerpt

The effect of a permanent increase in microwave fluxes from the environment on the activation of viral pandemics is considered. This is not only the radiation of the earth's ionosphere but also the anthropogenic electromagnetic background, caused by an avalanche-like increase in microwave pollution of the habitat during the operation of mobile cellular telephony, household computer equipment, and digitalization systems. The predicted interaction of natural and anthropogenic sources of microwaves sharply increases their negative impact on the ecological situation. Therefore, efforts are needed to reduce drastically the amount of time spent using mobile phones and surfing the Internet among at-risk populations, including secondary school students.

This wish of the authors is consistent with the concerns expressed recently by both teachers and parents of students, as well as with the opinion of the General Prosecutor's Office of the Russian Federation.

The proposed clarifications to the recommendations of experts on the protection of the population using electromagnetic shielding suggest the development of biophysical studies of the cumulative microwave impact both within heliobiology (at the present stage of the decline in the level of solar–geomagnetic activity) and taking into account the resonant mechanisms of increasing anthropogenic exposure at communication frequencies.
Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9107623/

SYMPTOMS REPORTED BY CANADIANS POSTED IN HAVANA ARE LINKED WITH REDUCED WHITE MATTER FIBRE DENSITY

Guillermo Aristi, Lyna Kamintsky, Margaux Ross, Chris Bowen, Cynthia Calkin, Alon Friedman, Javeria A. Hashmi. Symptoms reported by Canadians posted in Havana are linked with reduced white matter fibre density, Brain Communications. 4:2, 2022, fcac053, doi: 10.1093/braincomms/fcac053.

Abstract

Diplomats representing the USA have reported with unusual neurologic symptoms and MRI changes after being posted in Havana, Cuba between late 2016 and 2018. Here, we examined white matter microstructure and network connectivity of individuals stationed in Havana, using diffusion-weighted MRI, fixel-based analysis and structural connectomics as implemented in MRtrix3. MRI data acquisition and clinical assessments were done in a total of 24 diplomats and their family members and 40 healthy controls. The diplomat data were grouped into an exposed cohort (n = 16) and an unexposed cohort (n = 10), and among these,

two individuals were assessed before and after potential exposure. Fixel-based analysis revealed a reduction in fibre density in two specific regions: the fornix and the splenium, in exposed individuals, relative to unexposed individuals and healthy controls. Post hoc analyses showed the effect remained present ($P < 0.05$) in both regions when comparing exposed and unexposed diplomats; and reduced fibre density was correlated with longer time period stationed in Cuba after age correction. Reduction of fibre density was also found to be linked with clinical symptoms of persistent migraine, tinnitus, sound sensitivity and fatigue. Network statistical comparisons revealed decreased structural connectivity in two distinct networks, comprising subcortical and cortical systems in exposed individuals, relative to unexposed and normative data. While the cause for the differences between the groups remains unknown, our results reveal region-specific white matter injury, that is, significantly correlated with clinical symptoms.

https://academic.oup.com/braincomms/article/4/2/fcac053/6543087

MICROWAVE AUDITORY EFFECTS AMONG U.S. GOVERNMENT PERSONNEL REPORTING DIRECTIONAL AUDIBLE AND SENSORY PHENOMENA IN HAVANA

James C. Lin. Microwave Auditory Effects Among U.S. Government Personnel Reporting Directional Audible and Sensory Phenomena in Havana. IEEE Access, vol. 10, pp. 44577-44582, 2022, doi: 10.1109/ACCESS.2022.3168656.

Abstract

The mysterious incidents on diplomatic and intelligence personnel began in 2016. Since then, nearly 200 incidents have been reported. The illnesses and symptoms are called Havana Syndrome, named for the city where cases were first reported. The initial accounts from Havana include hearing of loud high-pitched sounds, localizing the sources as coming from above or behind the head, experiencing a directional sound that ceases if one steps away, the covering of ears not making any difference, some hearing the sound but others in the same room not hearing it, or hearing it in one part of a room but not in other areas. Assuming the reported symptoms and accounts are consistent, the microwave auditory effect provides a scientific explanation for Havana Syndrome.

Excerpts

Although the required peak power densities are high, they are achievable with existing high-power commercial and military microwave systems operating under pulsed conditions [25]. Significantly, they also fall within the permissible “safe” limits of currently promulgated safety standards and protection guidelines, The required microwave technology is mature and in general, commercially available in many developed countries. confirming the conclusion of earlier studies.

Furthermore, the study showed that to generate tissue injuring level of high-power microwave induced acoustic pressures inside the human brain, the theoretical microwave pulse induced temperature elevation would be substantially below 1o C (see Table 2), which is again “safe” according to currently promulgated RF and microwave safety protection guidelines.

https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9759429&isnumber=9668973

EDITORIAL: HUMAN EXPOSURE TO NEW-EMERGING ELECTRIC, MAGNETIC AND ELECTROMAGNETIC FIELDS

Wu Tongning, Peng Ruiyun, Zhang Lei, Li Kun. Editorial: Human Exposure to New-Emerging Electric, Magnetic and Electromagnetic Fields. Frontiers in Public Health, 10, 2022. doi: 10.3389/fpubh.2022.894624.

With the advancement of wireless technologies and electronic/electrical devices, humans are exposed to more complicated electric, magnetic, and electromagnetic fields (EMF), which has raised public concerns on potential health effects. Researchers have recently conducted a series of studies on diverse exposure scenarios. In addition, international standard organizations have revised safety guidelines and standards (1). These recent results and practices can enhance our knowledge in assessing health risks from the exposure to EMF (2). This

Research Topic consists of 14 articles (one review article, two brief research report articles, and 11 original research articles) published in the Radiation and Health section of Frontiers in Public Health....

Open access paper: https://www.frontiersin.org/article/10.3389/fpubh.2022.894624

View all 15 papers: https://www.frontiersin.org/research-topics/18504/human-exposure-to-new-emerging- electric-magnetic-and-electromagnetic-fields#articles

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PATERNAL RADIOFREQUENCY ELECTROMAGNETIC RADIATION EXPOSURE CAUSES SEX-SPECIFIC DIFFERENCES IN BODY WEIGHT TRAJECTORY AND GLUCOSE METABOLISM IN OFFSPRING MICE

Yan Song, Ju Ying, Dong Jie, Lei Hui, Wang Jun, Xu Qian, Ma Yefei, Wang Jingjing, Wang Xiaohong. Paternal Radiofrequency Electromagnetic Radiation Exposure Causes Sex-Specific Differences in Body Weight Trajectory and Glucose Metabolism in Offspring Mice. Frontiers in Public Health. 10, 2022. doi: 10.3389/fpubh.2022.872198.

Abstract

Nowadays, concerns about the harmful effects of radiofrequency electromagnetic radiation (RF-EMR) on male fertility and offspring health are growing. In the present study, we investigated the effects of long-term exposure (at least 10 weeks) to the RF-EMR [2.0 GHz; power density, 2.5 W/m2; whole-body specific absorption rate (SAR), 0.125–0.5 W/kg] on male mice fertility and F1 growth and glucose metabolism. No significant injuries were observed in testis organization, sperm quality, and pregnancy rate. However, mice exposed to RF-EMR exhibited a significantly elevated apoptosis rate in testis germ cells. Interestingly, paternal RF-EMR exposure resulted in sex-specific weight trajectory differences and glucose metabolism changes in male F1 mice but not in female F1 mice. The changed glucose metabolism in F1 male may result from the altered gene expression of liver Gck. These data collectively suggested that 2.0 GHz RF-EMR whole-body exposure of male mice does not cause obvious impairment in testis, sperm quality, and pregnancy rate. Paternal RF-EMR exposure causes male- specific alterations in body weight trajectories and glucose metabolism of F1.

Open access paper: https://www.frontiersin.org/article/10.3389/fpubh.2022.872198

MEASUREMENT AND EXPOSURE ASSESSMENT OF INTERMEDIATE FREQUENCY MAGNETIC FIELDS FROM ELECTRONIC ARTICLE SURVEILLANCE (EAS) GATES IN LIBRARIES

Ikuyo Miwa, Esaki Kaoru, Aimoto Atsuko, Wake Kanako, Yamaguchi-Sekino Sachiko, Kojimahara Noriko, Suzuki Yukihisa, Taki Masao. Measurement and Exposure Assessment of Intermediate Frequency Magnetic Fields From Electronic Article Surveillance (EAS) Gates in Libraries. Frontiers in Public Health. 10, 2022. doi: 10.3389/fpubh.2022.871134.

Abstract

Exposure to magnetic fields from the electronic article surveillance (EAS) gate was evaluated in consideration of the application to epidemiological studies of library workers who are exposed continually to intermediate frequency magnetic fields from the EAS gate. Two types of exposures were investigated. One was transient exposure due to passing through or beside the gate and another was chronic exposure in the room. We measured magnetic fields from five EAS gate models which were commonly used in libraries in Japan. Detailed measurements were performed for two of them in consideration of the phase difference of vector components of magnetic flux density. The polarization of the magnetic field in the gate was investigated with the index of ellipticity. The induced electric field in a human body was numerically calculated for exposures to magnetic fields of the two gate models. The results provide a quantitative understanding of exposures during passing through or by the EAS gate. Magnetic field distribution was measured in a large room for one gate model to quantify the chronic exposure of library workers during the work at the desk. It was found that the magnetic field was distributed as a function of the horizontal distance to the nearest gatepost. The 45-point average value BIEC defined by the IEC standard was suggested to be a useful quantity to characterize the magnitude of the magnetic field from the EAS gate. Exposures to different EAS gates are expected to be compared through this quantity without detailed measurements. These results are expected to provide useful means for exposure assessment of epidemiological studies on the association between the IF-EMF exposure and possible health outcomes.

Open access paper: https://www.frontiersin.org/article/10.3389/fpubh.2022.871134

LETTER TO THE EDITOR "MOBILE PHONE ELECTROMAGNETIC RADIATION AND THE RISK OF HEADACHE: A SYSTEMATIC REVIEW AND META-ANALYSIS"

Jalilian, H., Dongus, S., Bosch-Capblanch, X. et al. Letter to the Editor "Mobile phone electromagnetic radiation and the risk of headache: a systematic review and meta-analysis". Int Arch Occup Environ Health. 2022. doi: 10.1007/s00420-022-01890-4

In conclusion, this review has not followed a systematic approach and should thus not be labeled as a systematic review. Calculating only an average effect estimate based on a convenient sample of studies without addressing potential risk of bias and not considering the duration and level of exposure is largely uninformative.

https://link.springer.com/article/10.1007/s00420-022-01890-4

INVESTIGATION OF THE IMPACT OF ELECTROMAGNETIC FIELDS EMITTED CLOSE TO THE HEAD BY SMART GLASSES

Philipp Jungk, Matthias Wienke, Christoph Schiefer, Ulrich Hartmann, Volker Harth, Claudia Terschüren, Carsten Alteköster, Daniel Friemert. Investigation of the impact of electromagnetic fields emitted close to the head by smart glasses. Biomed Tech (Berl). 2022 May 17. doi: 10.1515/bmt-2021-0301.

Abstract

The functionality of smart glasses includes the possibility of wireless communication. For this purpose, WiFi or Bluetooth modules are integrated into the glasses. They emit electromagnetic radiation in the vicinity of the user's head. This simulation study investigates the impact of varying positions, frequencies, and antenna types of the embedded WiFi or Bluetooth modules on different tissue types in the human head. The absorption of electromagnetic energy causes the main impact on the tissue in the head. This physical process is best described by the specific absorption rate SAR. To investigate the effects of position, frequency, and antenna type on the simulated SAR values multiple simulations have been carried out considering real-world applications of smart glasses. The results show that the type of antenna has little effect on the SAR values of the different tissues. The maximum regulated output powers explain the frequencies' impact on the exposure. According to our findings, the greatest influence on the SAR values can be attributed to the placement of the antenna. Finally, our study reveals that positioning the antenna at the front side of the head is optimal for most tissues because of its maximal distance to the head tissues.

https://pubmed.ncbi.nlm.nih.gov/35580838/

5G NR BASE STATION EXPOSURE OF THE GENERAL PUBLIC: COMPARISON OF ASSESSMENT METHODS

Kenneth Deprez, Leen Verloock, Loek Colussi, Sam Aerts, Matthias Van den Bossche, Jos Kamer, John Bolte, Luc Martens, David Plets, Wout Joseph. In-Situ 5G NR Base Station Exposure of the General Public: Comparison of Assessment Methods. Radiat Prot Dosimetry. 2022 May 3;ncac061. doi: 10.1093/rpd/ncac061.

Abstract

New measurement methods and equipment for correct 5G New Radio (NR) electromagnetic field (EMF) in-situ exposure assessment of instantaneous time-averaged exposure (Eavg) and maximum extrapolated field exposure (Emax) are proposed. The different options are investigated with in-situ measurements around 5G NR base stations (FR1) in different countries. The maximum electric field values satisfy the ICNIRP 2020 limit (maximum 7.7%). The difference between Emax and Eavg is <3 dB for the different measurement equipment at multiple sites in case there is only self-generated traffic. However, in a more realistic scenario, Eavg cannot be used to assess the exposure correctly due to influence of other users as the spatial distribution of user equipment (UE) influences Eavg, while Emax is not affected. However, when multiple UEs are collocated, there is no influence of the number of UEs. A broadband measurement can give a first impression of the RF-EMF exposure up to 700 m, but is not enough to assess the 5G-NR exposure.

Conclusions and Future Work

This paper provides an overview of different measurement equipment and optimal settings that can be used to correctly perform in-situ 5G NR electromagnetic field exposure assessment at 3.5 GHz (FR1). Both time-averaged exposure and maximum extrapolated field exposure assessment are proposed and investigated with in-situ measurements in different countries. The maximum electric field values satisfy the ICNIRP 2020 limit (i.e.maximum 7.7%). Furthermore, in a low-traffic environment, one UE is sufficient to attract the beam towards the measurement equipment. The difference between Emax and Eavg is <3 dB for the different measurement equipment at multiple sites. Hence, the current setups are to be recommended in 5G-NR exposure assessment in the current low-traffic scenarios. In a more realistic scenario, not all measurement methods are valid and must thus be adapted. When Eavg is used as metric, the exposure assessment drops with 6 dB when four UEs are spatially separated. However, Emax is not affected by the spatially separated UEs (difference of 0.60 dB between the various measurements) and is the recommended metric to use for exposure assessment in high- traffic environments.

A broadband measurement can give a first impression of the RF-EMF environment up to 700 m (deviations of 0.05–4.86 dB), but is limited in use (larger separations) and not enough to assess the 5G-NR field exposure.

The future work can be divided into two main parts. The first part is to test the measurement methods and equipment in more realistic, higher traffic environments. This will give a more accurate view on the impact of 5G NR on everyday RF-EMF exposure. The second part is to test the measurement methods for the frequency range 2 of 5G-NR (FR2), i.e. mm-waves. Here, more beams, higher bandwidths and more traffic are expected.
https://pubmed.ncbi.nlm.nih.gov/35511688/

ON THE EXPOSURE DOSE MINIMIZATION OF MULTI-ANTENNA MULTI-CARRIER SYSTEM USERS

F. Heliot, T. Brown. On the Exposure Dose Minimization of Multi-antenna Multi-carrier System Users.IEEE Transactions on Vehicular Technology. Apr 27, 2022. doi: 10.1109/TVT.2022.3170606.

Abstract

From the fourth generation (4G) of cellular systems onward, wireless personal devices (WPDs) support multi- input multi-output (MIMO) communication. However, the impact of MIMO communication on the electromagnetic field (EMF) of WPD users has yet to be fully understood and analyzed at the system level. In this paper, we first provide a generic model for assessing the individual exposure dose of multi-antenna WPD users in a multi-user multi-carrier communication system. An optimization framework for minimizing this exposure dose is then developed based on our exposure model. This framework helps us to identify a new criterion, i.e., the ratio between the normalized exposure dose and the channel to noise ratio (CNR), as the main system level criterion for minimizing the individual exposure dose of multi-antenna WPD users. This criterion is further integrated in the design of two novel centralized resource allocation schemes that take advantage of the multiple antennas at the WPD to minimize the per-user exposure dose, when full or limited knowledge of each user channel is available. Our new schemes can significantly reduce the individual exposure dose of WPD

users (by approximately \$80\%\$) in comparison with the most relevant existing resource allocation schemes. Our results also provide insights into the logarithmic relationship between the per-user exposure dose and the number of receive antennas (or the number of time slots), and how such a parameter can be exploited to further reduce the exposure and/or provide a higher SE while maintaining a low exposure dose.
https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9764644&isnumber=4356907

METHODOLOGY TO DETERMINE THRESHOLD DISTANCE FOR ESTIMATING MAIN ELECTROMAGNETIC EXPOSURE IN WIRELESS LOCAL AREA NETWORK (WIFI)

Marta Fernández, David Guerra. Methodology for determining the threshold distance for estimating the main EM exposure contribution in WLAN. Engineering Science and Technology, an International Journal. Volume 25, 2022, 100997. doi:10.1016/j.jestch.2021.05.001.

Abstract

The location of radiation sources in wireless networks is a key factor to characterize their contribution to electromagnetic exposure levels in order to deploy future networks that account for minimizing electromagnetic field levels. In relation to wireless local area networks, considering that mobile communication devices comply with the SAR (Specific Absorption Rate) limits imposed by the international standardization organizations for preserving human health, the interest is nowadays focused on the signal levels coming from the WiFi access points. This paper presents a methodology to determine the threshold distance at which the field strength levels from the AP are negligible in comparison with the radiation generated by a user equipment. The theoretical concepts, which can be applied to other technologies, were implemented by means of simulations and experimental measurements. For the simulations, actual WiFi antennas were modelled. Experimental measurements completed the results obtained in simulations, resulting in a greater number of real situations.

Results showed that the threshold distance depends on the WiFi standard employed by the devices connected to the network.

Open access paper: https://www.sciencedirect.com/science/article/pii/S2215098621001099

QUASI-DETERMINISTIC CHANNEL PROPAGATION MODEL FOR 60 GHZ URBAN WIFI ACCESS FROM LIGHT POLES

S.Y. Jun, C. Lai, D. Caudill, J. Wang, J. Senic, N. Varshney, C. Gentile. Quasi-Deterministic Channel Propagation Model for 60 GHz Urban WiFi Access from Light Poles. IEEE Antennas and Wireless Propagation Letters. Published online Apr 29, 2022. doi: 10.1109/LAWP.2022.3171503.

Abstract

There is strong impetus by the Telecom Infra Project to exploit the 60 GHz unlicensed band for public WiFi in urban environments, by installing access points on light poles. Although many 60 GHz urban channel measurements have been recorded to date, they have resulted only in path loss models or RMS delay spreads. What is needed at millimeter-wave is a spatially consistent channel model for beamtracking that embodies the characteristics of these short wavelengths sparsity and rough surface scattering such as the Quasi-Deterministic model. In this letter, we fit the model to channel measurements we recorded in an urban

environment. The measurements were recorded at 4 m, 6 m, and 9 m antenna heights to investigate the tradeoffs between light pole heights. The large-scale channel metrics between the model and the measurements were shown to match very well.
https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9765658&isnumber=4357943

EFFECTS OF LONG-TERM AND MULTIGENERATION EXPOSURE OF CAENORHABDITIS ELEGANS TO 9.4 GHZ MICROWAVES

Sun A, Zhao X, Li Z, Gao Y, Liu Q, Zhou H, Dong G, Wang C. Effects of Long-Term and Multigeneration Exposure ofCaenorhabditis elegans to 9.4 GHz Microwaves. Bioelectromagnetics. 2022 May 11. doi: 10.1002/bem.22409.

Abstract

A large number of studies on the biological effects of microwaves are carried out using rodents and cells, but the conditions are difficult to control, and the irradiation period is short; the results obtained have always been controversial and difficult to reproduce. In this study, we expose nematodes to an electromagnetic environment for a long-term and multigeneration period to explore the possible biological effects. Wild-type N2 strains of Caenorhabditis elegans are exposed to 9.4 GHz microwaves at a specific adsorption rate of 4 W/kg for 10 h per day from L1 larvae to adults. Then, adult worms are washed off, and the laid eggs are kept to hatch L1 larvae, which are continuously exposed to microwaves until passing through 20 generations. The worms of the 10th, 15th, and 20th generations are collected for index detection. Interestingly, we found that the fecundity of C. elegans decreased significantly in the exposed group from the 15th generation. At the same time, we found that the growth of C. elegans decreased, motility decreased, and oxidative stress occurred in the exposed group from the 10th generation, which may play roles in the decreased spawning in worms. We preliminarily believe that the microwave energy received by worms leads to oxidative stress, which causes a decrease in the spawning rate, and the underlying mechanism needs to be further studied.
https://pubmed.ncbi.nlm.nih.gov/35544783/

SEMI-QUANTITATIVE METHODOLOGY TO ASSESS HEALTH AND SAFETY RISKS ARISING FROM EXPOSURE TO ELECTROMAGNETIC FIELDS UP TO 300 GHZ AT WORKPLACES ACCORDING TO ITALIAN REGULATIONS

Laura Filosa, Vanni Lopresto. Semi-quantitative methodology to assess health and safety risks arising from exposure to electromagnetic fields up to 300 GHz at workplaces according to Italian regulations. Int J Occup Saf Ergon. 2022 May 16;1-41. doi: 10.1080/10803548.2022.2077511. 3557482410803548.2022.2077511.

Abstract

This paper is focused a semi-quantitative methodology to assess and manage the health and safety risks arising from exposure to electromagnetic fields (EMF) up to 300 GHz at workplaces as well as to identify the priorities of intervention, based on the requirements of European directive 2013/35/EU and Italian regulations. The study includes a synthetic overview on the effects arising from EMF exposure and the related regulatory framework on protection. Furthermore, an in-depth analysis is carried-out on the risk assessment process as well as on the technical and organisational measures for risk mitigation and their adaptation to the

specific requirements of workers at particular risk, based on technical standards and best practice guides issued by international and national (Italian) standardisation bodies.

Conclusions

The EMF risk assessment process outlined in this paper takes into account the provisions of Directive 2013/35/EU [32] and of technical standard EN 50499:2019 [48], as well as the peculiar requirements of Italian regulations as referred to in the Framework Law 36/2001 [43] and relevant implementation decrees [41][42] along with the Legislative Decree 81/2008 and s.m.a. [39]. To this end, a useful compass to assess and manage EMF exposure at workplaces taking into account the specific provisions of Italian regulations is represented by the EMF Guide CEI 106-45 [44].

A semi-quantitative methodology for EMF risk assessment is proposed based on a two-dimensional matrix for risk analysis. The matrix reports the indexes of risk calculated as the product of the severity rate of a dangerous event and the likelihood of occurrence of such an event. The severity rating assigned to the effect should reflect the expected outcome of the hazardous event, meanwhile the probability of occurrence should take into account a number of factors related to the workplace and work practice. In relation to assessed index of risk can be identified the prevention and protection measures for risk mitigation as well as the intervention priorities, which shall be adapted to the workers at particular risk. The outcomes of the risk assessment process should be documented in the risk assessment report along with the improvement actions included in the Company Program for the Reduction of Exposure to EMF. https://pubmed.ncbi.nlm.nih.gov/35574824/

EVALUATION OF OXIDATIVE STRESS AND GENOTOXICITY OF 900 MHZ ELECTROMAGNETIC RADIATIONS USING TRIGONELLA FOENUM-GRAECUM (FENUGREEK) TEST SYSTEM

Surbhi Sharma, Shalini Bahel, Jatinder Kaur Katnoria. Evaluation of oxidative stress and genotoxicity of 900 MHz electromagnetic radiations using Trigonella foenum-graecum test system. Protoplasma. 2022 May 11. doi: 10.1007/s00709-022-01768-9.

Abstract

Unprecedented growth in the communication sector and expanded usage of the number of wireless devices in the past few decades have resulted in a tremendous increase in emissions of non-ionizing electromagnetic radiations (EMRs) in the environment. The widespread EMRs have induced many significant changes in biological systems leading to oxidative stress as well as DNA damage. Considering this, the present study was planned to study the effects of EMRs at 900 MHz frequency with the power density of 10.0 dBm (0.01 W) at variable exposure periods (0.5 h, 1 h, 2 h, 4 h, and 8 h per day for 7 days) on percentage germination, morphological characteristics, protein content, lipid peroxidation in terms of malondialdehyde content (MDA), and antioxidant defense system of Trigonella foenum-graecum test system. The genotoxicity was also evaluated using similar conditions. It was observed that EMRs significantly decreased the germination percentage at an exposure time of 4 h and 8 h. Fresh weight and dry weight of root and shoot did not show significant variations, while the root and shoot length have shown significant variations for 4 h and 8 h exposure period. Further, EMRs enhanced MDA indicating lipid peroxidation. In response to exposure of EMRs, there was a significant up-regulation in the activities of enzymes such as ascorbate peroxidase (APX), superoxide dismutase (SOD), glutathione-S-transferase (GST),

guaiacol peroxidase (POD), and glutathione reductase (GR) in the roots and shoots of Trigonella-foenum graecum. The genotoxicity study showed the induction of chromosomal aberrations in root tip cells of the Trigonella foenum-graecum test system. The present study revealed the induction of oxidative stress and genotoxicity of EMRs exposure in the test system. https://pubmed.ncbi.nlm.nih.gov/35546647/

A SYSTEMATIC METHOD TO EXPLORE RADIO-FREQUENCY NON-THERMAL EFFECT ON THE GROWTH OF SACCHAROMYCES CEREVISIAE

D. Ye, G. Cutter, T. P. Caldwell, S. W. Harcum, P. Wang.IEEE Journal of Electromagnetics, RF and Microwaves in Medicine and Biology. 6(1):52-60. March 2022, doi: 10.1109/JERM.2021.3101408.

Abstract

Radio frequency (RF) non-thermal (NT) bio-effects have been a subject of debate and attracted significant interests due to potential health risks or beneficial applications. In this work, we report a systematic method for broadband investigation of RF NT effects on Saccharomyces cerevisiae yeast growth. The method includes a transverse electro-magnetic (TEM) device and a dielectric spectroscopy technique for RF frequency selection. A stripline-based TEM device has two 240-µL chambers 3D printed for cell cultures. The fabricated device operates up to a few GHz and produces uniform RF fields for cell exposure testing. A vector network analyzer (VNA) was used to provide ~20 dBm continuous-wave (CW) RF power. The heating effects on cell growth were estimated to be negligible. Frequency regions, where large permittivity differences between the medium and yeast cultures were obtained and used to select RF testing frequencies, e.g., 1.0 MHz, 3.162 MHz, 10 MHz. These differences may indicate RF field gradients near cell membrane, and the gradients may affect local nutrient transport. Additionally, RF at 905 MHz is tested for comparison purpose. Yeast cells in the exponential growth phase were examined at four RF frequencies and compared with two controls. One control device held at the same temperature as the test device, while the other control was held at a temperature 1 degree C higher. The results showed that the RF fields at 3.162 MHz reduced yeast growth rates by 15.1%; however, the RF fields at
1.0 MHz enhanced cell growth by 13.7%, while the observed 4.3% growth rate increase at 10 MHz is insignificant and the RF fields at 905 MHz had no effects on the cell growth. These results showed a clear RF NT effects on S. cerevisiae growth that was frequency dependent. The hypothesized mechanisms of these effects, i.e., non- uniform RF fields near cell membranes and fluidic diodes in cell membrane ion channels may play important roles in nutrient transport, need to be further investigated.
https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9502940&isnumber=9716150

COMPARISON OF THE EFFECT OF CHANGING THE SPATIAL DISTANCE WITH EXPOSURE TIME TO MOBILE PHONES RADIATION ON THE STRUCTURE AND FUNCTION OF THE TESTIS IN NMRI MICE

Homa Soleimani, Mahbobeh Gafori Ghadarijani, Fatemeh Rafiei, Parvindokht Bayat. Journal ofMicrowave Power and Electromagnetic Energy, 56(2):87-102. 2022. doi:10.1080/08327823.2022.2066769.

Abstract

The present study was conducted to compare the effect of changing the spatial distance and time radio frequency (RF) radiation from mobile phone in standby mode on the structure and function of testicles. NMRI mice were randomly divided into three groups. The first group was the control and the second group (exposed group) was divided into four subgroups: groups A (A1 and A2) and groups B (B1 and B2), which were placed in plastic holder units at two distances of 5 cm and 20 cm from RF radiation, respectively. A1 and B1, and A2 and B2 were exposed to RF radiation for six and 10 weeks, respectively. The exposure duration was 5 days/week, 6 hours/day. The third group with two subgroups (sham1 and sham2) were kept in plastic holder units without being exposed to radiation and were evaluated after six and 10 weeks, respectively. The changes in the external diameters of seminiferous tubules and the height of germinal epithelium obviously depended more on the distance from the radiation source than on the exposure time. The decrease in the diameter of the testicles and sperm motility were found to be time-dependent. These effects had a clear but unpredictable dependence on the two variables of distance and RF radiation time.

Excerpts

The intensity of waves was measured at a distance of 5 and 20 cm every 10 seconds in water within 6 minutes (the time of thermal balance of human body, at a density similar to the body density). Measurement of the electromagnetic field intensity showed that the mean value in both cases, without mobile phone (1.39 μW/m2) and with the mobile phone, in standby mode at a distance of 20 cm were almost equal. However, the amount of electromagnetic field fluctuated over time in the presence of a mobile phone (Table 1)....

We also exhibited that each of the factors of stress and radiation alone led to a significant decrease in sperm motility (Grade 1 and 2). Meanwhile, the effects of stress and RF field were not synergistic. Moreover, sperm motility (Grade 1) in sham2 group was not significantly different with that in control group. This may be attributed to the adaptation of biological tissues to stressor factors.

It seemed as though the effect of RF field and decreased distance from the radiation source leads to a decrease in the rate of sperm in Grades 1 and 2 and an increase rate sperm in Grades 3 and 4. According to the obtained results, the effect of the RF exposure on sperm motility might probably change according to the distance from the radiation source, which is more important than the exposure time.

Conclusion

This research shed light on the fact that although decreased distance or increased irradiation time led to histological or physiological changes in the structure and function of the male reproductive system, these effects were not similar. These changes had significant impacts,

but unforeseeable dependence, on the two variables of distance and radiation time of mobile phone in standby mode. Our findings also depicted the significant and superior role of stress against mobile phone radiation in the decrease in the diameter of testis, sperm motility, and the reduction in sperm count. Furthermore, stress was the predominant factor in comparison with radiation exposure and once the stress was eliminated due to the habituation of the animal, the biological effects of radiation exposure on the tissue became detectable.
https://www.tandfonline.com/doi/abs/10.1080/08327823.2022.2066769?journalCode=tpee20

PRELIMINARY CHRONIC EFFECTS OF RADIATION FROM MOBILE PHONES ON HEART RATE VARIABILITY, CARDIAC FUNCTION, BLOOD PROFILES, AND SEMEN QUALITY IN HEALTHY DOGS

Dong VNK, Tantisuwat L, Setthawong P, Tharasanit T, Sutayatram S, Kijtawornrat A. The Preliminary Chronic Effects of Electromagnetic Radiation from Mobile Phones on Heart Rate Variability, Cardiac Function, Blood Profiles, and Semen Quality in Healthy Dogs. Vet Sci. 2022 Apr 21;9(5):201. doi: 10.3390/vetsci9050201.

Abstract

The present study aims to determine the effects of long-term exposure to electromagnetic radiation from mobile phones (MPs) on heart rate variability (HRV), cardiac function, blood profiles, body surface temperature, and semen quality in healthy dogs. Eight male dogs were exposed to MPs (1962-1966 MHz; specific absorption rate 0.96 W/kg) for 2 h/day, 5 days/week, for 10 weeks. Holter monitoring for HRV analysis was performed at baseline (BL) and every 2 weeks, until the end of the study. Electrocardiograms (ECG), blood pressure (BP), echocardiography, cardiac troponin I (cTnI), hematology and biochemistry profiles, body surface temperature, and semen quality were evaluated at BL, week 5, and week 10 during exposure. The results showed that most of the HRV parameters did not significantly differ among timepoints, except for the mean of an interval between continuous normal R waves in week 6 that was higher than that at BL ($p = 0.022$). The RR and QT intervals from ECG in week 5 were prolonged, compared to the BL values ($p = 0.001$ and $p = 0.003$, respectively), but those parameters were within the normal limits. The echocardiography, BP, cTnI concentrations, body surface temperature, and semen quality results were not different from BL values. In conclusion, this study found no evidence suggesting an adverse effect of cell phone exposure on HRV, cardiac function, blood profiles, body surface temperature, or semen quality in healthy dogs, when exposed for 10 weeks.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9147188

EXPERIMENTAL EVIDENCE OF RADIO FREQUENCY RADIATION FROM STAPHYLOCOCCUS AUREUS BIOFILMS

M. Rao, K. Sarabandi, J. Soukar, N. A. Kotov and J. S. VanEpps. Experimental Evidence of Radio Frequency Radiation From Staphylococcus aureus Biofilms.IEEE Journal of Electromagnetics, RF and Microwaves in Medicine and Biology, doi: 10.1109/JERM.2022.3168618.

Abstract

This paper reports the first successful detection of electromagnetic (EM) radiation from Staphylococcus aureus biofilms in the gigahertz (GHz) frequency range. Two novel sensing systems are deployed for the measurement. A very sensitive wideband near-zone radiative

system specifically designed for this application is first used to search for signals in the 1–50 GHz frequency region. Notable radiation is observed in the 3–4 GHz band.

Exposure to lethal doses of Zinc oxide nanopyramids (ZnO-NPY) is used to verify that the signals are indeed produced by living cells rather than material thermal emission. Afterwards, a spiral antenna system is exploited to further examine the band of interest in the near-field region. Radiation from 3 identical biofilm samples is monitored and recorded over 70 days. Two distinct frequency bands, namely the 3.18 GHz and the 3.45 GHz bands, are identified as potential "communication bands". Furthermore, long-term and short-term cycles of the total radiation intensity within the band are observed over the course of the experiment. This work confirms the presence of EM radiation within bacterial communities, which is a key requirement to demonstrate EM signaling among bacterial cells. The insight could lead to breakthroughs in demystifying how cells communicate as well as advancement of important technologies in biology and communication systems.

Conclusion

Although it has long been suggested that biological cells may transmit and receive EM waves, no prior convincing experimental evidence has been generated to support this hypothesis prior to this paper. Our work is the first successful attempt to measure EM radiation from S. aureus biofilms in the GHz frequency range. Two measurement systems are used in the experiments. Two distinct radiating bands in the 3-4 GHz frequency range are identified. Over the course of a 70-day experiment, we discovered a long-term cycle of the radiated signal with short-term fluctuations. This work proves the existence of EM radiation in biofilm communities, which is validated by examining multiple samples over a long period of time and comparing the measured power with that of PNG media (no biofilms) in the same petri dish. In addition, it is shown that exposing biofilms with significant RF radiation to lethal doses of ZnO-NPYs, which inhibits metabolic activity, eliminates the biofilm RF emission.

https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9771271&isnumber=8000303

EXPOSURE EFFECTS OF NON-IONIZING RADIATION OF RADIO WAVES ON ANTIMICROBIAL POTENTIAL OF MEDICINAL PLANTS

Chandni Upadhyaya, Trushit Upadhyaya, Ishita Patel. Exposure effects of non-ionizing radiation of radio waves on antimicrobial potential of medicinal plants. Journal of Radiation Research and Applied Sciences. 15(1):1-10. 2022. doi:10.1016/j.jrras.2022.01.009.

Abstract

The high frequency electromagnetic (EM) waves have been proven as potent environmental polluters. The radio towers are considerably increasing to cater to the growing telecommunication requirements. The presented research focuses on the investigation of EM waves on antimicrobial potential of pharmaceutically important medicinal plants viz. Tulsi (Ocimum sanctum L.) and Brahmi (Bacopa monnieri). The similar work has not been reported till date at the best of our knowledge. The medicinal plants were exposed to EM waves of 900 MHz possessing a 1.9 mG magnetic field. Our former investigation on plant physiology gave deteriorative effects on selected plants physiology in terms of growth, chlorophyll content, protein and carbohydrate content. In the presented article, the antimicrobial activity of two plants was inspected through various bacterial and fungal species. In case of B. monnieri, investigations revealed raise in Zone of Inhibition (ZOI) for both the bacterial and fungal

strains in the range of 50%, whereas for O. sanctum increase of 63.26% and 59.42% ZOI for bacterial and fungal strains were noted respectively upon 24 h of exposure. Minimum Inhibitory Concentration (MIC) also decreased for 24 and 48 h of exposure. The transient raise in antimicrobial activity indicated the induction of plant defense system which can be considered as positive influence of short term radiation on medicinal properties of plants. Both plants exhibited the highest antimicrobial potential for E. coli and P. chrysogenum showing a prominent decline after 72 h of exposure. A substantial decline in antimicrobial in MIC of B. monnieri reported was 211% against E. coli and 166% against P. chrysogenum upon 144 h of exposure compared to control plants. The antimicrobial potential of O. sanctum was also decreased upon radiation, which is having a 392% reduction against E. coli and a 225% reduction against P. chrysogenum upon 144 h of exposure. The noteworthy deteriorative effects of radio waves on antimicrobial potential have been observed for both the medicinal plants. https://www.sciencedirect.com/science/article/pii/S1687850722001091

MAGNETIC FIELD INTERACTIONS BETWEEN CURRENT CONSUMER ELECTRONICS AND CARDIAC IMPLANTABLE ELECTRONIC DEVICES

Xu K, Sengupta J, Casey S, Peltier J, Stahl W, Peterson N, Settimi D, Taylor A, Kippola J, Steele E, Hauser R. Magnetic field interactions between current consumer electronics and cardiac implantable electronic devices. J Interv Card Electrophysiol. 2022 May 10. doi: 10.1007/s10840-022-01241-w.

Abstract

Background: Electronic products, including the iPhone 12, Apple Watch Series 6, and 2nd Generation AirPods, contain magnets to facilitate wireless charging. Permanent magnets may affect CIED magnet mode features by causing pacemakers to pace asynchronously and defibrillators to suspend arrhythmia detection. This study determined if CIEDs are affected by static magnetic fields from commonly used portable electronics (PE) at any distance and intends to reinforce FDA recommendations concerning consumer PE which contain permanent magnets.

Methods: The maximum magnet field measurement was evaluated by a Gauss meter. The interaction between PE and CIEDs from Boston Scientific and Medtronic were tested ex vivo using a body torso model. The CIED was placed in physiologic saline, and the PE was placed at the surface and at increasing distances of 0.5, 1.0, and 1.5 cm. Interactions were recorded by assessment of magnet mode status.

Results: The iPhone 12 had almost three times the static magnetic field measured at the surface as the iPhone XR, but magnetic field strength decreased dramatically with increasing distance. At the surface of the model, PE triggered magnet mode in all CIEDs. The maximum interaction distance for all combinations of CIEDs and Apple products was 1.5 cm.

Conclusions: The iPhone 12 produces a stronger static magnetic field than previous iPhone models. Magnets in PE tested will not interact with CIEDs when they are 15 cm from the implanted device. Since no interaction was observed beyond 1.5 cm, it is unlikely that magnet mode activation will occur during most daily activities.

https://pubmed.ncbi.nlm.nih.gov/35538270/

EXPOSURE OF INFANTS TO GRADIENT FIELDS IN A BABY MRI SCANNER

Fangfang Tang, Luca Giaccone, Jiahao Hao, Fabio Freschi, Tongning Wu, Stuart Crozier, Feng Liu. Exposure of Infants to Gradient Fields in a Baby MRI Scanner. Bioelectromagnetics. 2022 Feb;43(2):69-80. doi: 10.1002/bem.22387.

Abstract

In pediatric magnetic resonance imaging (MRI), infants are exposed to rapid, time-varying gradient magnetic fields, leading to electric fields induced in the body of infants and potential safety risks (e.g. peripheral nerve stimulation). In this numerical study, the in situ electric fields in infants induced by small-sized gradient coils for a 1.5 T MRI scanner were evaluated. The gradient coil set was specially designed for the efficient imaging of infants within a small-bore (baby) scanner. The magnetic flux density and induced electric fields by the small x, y, z gradient coils in an infant model (8-week-old with a mass of 4.3 kg) were computed using the scalar potential finite differences method. The gradient coils were driven by a 1 kHz sinusoidal waveform and also a trapezoidal waveform with a 250 μs rise time. The model was placed at different scan positions, including the head area (position I), chest area (position II), and body center (position III). It was found that the induced electric fields in most tissues exceeded the basic restrictions of the ICNIRP 2010 guidelines for both waveforms. The electric fields were similar in the region of interest for all coil types and model positions but different outside the imaging region. The y-coil induced larger electric fields compared with the x- and z- coils.
https://pubmed.ncbi.nlm.nih.gov/35005795/

Conclusions

In this paper, we have numerically studied the field exposure of an infant model inside the baby x, y, z gradient coils during an MRI scan. The B-fields have exceeded the reference level 0.08 mT in most tissues for the frequency 1 kHz in ICNIRP 2010 guidelines. Based on the simulation results, it has been found that baby positioning primarily affected the induced E-field profiles. In most tissues, the EI values are larger than 1, indicating that the exposures have exceeded the reference level 0.4 V/m in ICNIRP 2010 guidelines for the frequency of 1 kHz. The largest E99.9% and EI are 5.41 V/m and 9.56, found in fat produced by y-coil in position III. The EI is determined based on the basic restrictions of ICNIRP 2010 guidelines; the results are possibly conservative as applicable guidelines/restrictions are not yet accessible for exposure of infants in MRI gradient fields.

The field exposure varies due to the variation of the driving current and rise time. It is likely stronger when all three gradient coils are switched faster and simultaneously during a realistic MRI scan. Further work is required to characterize more realistic field-infant tissue interactions with detailed nerve models, and it is hoped that these simulations will help inform compliance of clinical procedures.

THE EFFECT OF EXPOSURE TO NON-IONISING RADIOFREQUENCY FIELD ON ESCHERICHIA COLI, KLEBSIELLA OXYTOCA AND PSEUDOMONAS AERUGINOSA BIOFILMS

Dobroslava Bujňáková, Samuel Bucko, Marek Češkovič, Vladimír Kmeť, Lívia Karahutová. The effect of exposure to non-ionising radiofrequency field on Escherichia coli, Klebsiella oxytoca and Pseudomonas aeruginosa biofilm. Environ Technol. 2022 May 4;1-21. doi: 10.1080/09593330.2022.2074317.

Abstract

An environment with a higher accumulation of electromagnetic non-ionising radiofrequency (RF) emissions generated by various telecommunication, data transport and navigation devices (mobile phones, Wi-Fi, radar, etc.) may have a major impact on biological systems. This study aimed to evaluate the incidence of an electromagnetic field (EMF) on the development of bacterial biofilm. Quantification of biofilm production was done by using microtiter plate assay. Bacterial isolates of Escherichia coli, Klebsiella oxytoca and Pseudomonas aeruginosa were exposed with EMF of frequencies 1-5 and 2.4 GHz with an exposure time 3 or 24 hours, respectively. Exposure of bacteria to EMF produced a statistically significant increase in biofilm production mainly at 1, 2 and 4 GHz, and in contrast, a significant inhibition of biofilm development occurred at frequencies 3 and 5 GHz, both with exception of Klebsiella oxytoca and Pseudomonas aeruginosa. Wi-Fi operating at 2.4 GHz caused biofilm reduction. The results indicate that EMF exposure act on bacteria in both ways, depending on the frequency: as stressful by enhancing bacterial biofilm formation (under environmental stress, bacteria produce a polysaccharide matrix and aggregate to form biofilms to increase virulence and resistance), although some frequencies leading to biofilm damage could be caused by changes to the physicochemical properties of bacteria.

Conclusions

In conclusion, the results of our study revealed that EMF can stimulate/inhibit the ability of Escherichia coli, Klebsiella oxytoca and Pseudomonas aeruginosa to form biofilms, depending on the frequency and/or specific type of bacteria used. Based on the acquired results of the biofilm modulation (increasing/decreasing) EMF can also be expected to influencs the pathogenicity of microorganisms, since biofilm-associated bacteria are considered more resistant and difficult to treat; however, some results demonstrated EMF as a potential tool for biofilm removal, for example, on medical devices and biomaterials. Further studies are in progress (and need to be performed) to extend the current state of knowledge of the influence of EMF on microorganisms and to gather more information on other bacterial biological changeovers that may occur due to exposure to EMF, including antibiotic susceptibility (resistance) as a next substantial factor of bacterial pathogenicity. Undervaluing the problem of exposure to electromagnetic non-ionising RF radiation generated by various telecommunication and data transport as common part of the environment could lead to a further rise in infectious diseases or their complications.

https://pubmed.ncbi.nlm.nih.gov/35506486/

THAPSIGARGIN BLOCKS ELECTROMAGNETIC FIELD-ELICITED INTRACELLULAR CA 2+ INCREASE IN HEK 293 CELLS

Federico Bertagna, Rebecca Lewis, S Ravi P Silva, Johnjoe McFadden, Kamalan Jeevaratnam. Thapsigargin blocks electromagnetic field-elicited intracellular Ca 2+ increase in HEK 293 cells. Physiol Rep. 2022 May;10(9):e15189. doi: 10.14814/phy2.15189.

Abstract

Biological effects of electromagnetic fields (EMFs) have previously been identified for cellular proliferation and changes in expression and conduction of diverse types of ion channels. The major effect elicited by EMFs seems to be directed toward Ca2+ homeostasis. This is particularly remarkable since Ca2+ acts as a central modulator in various signaling pathways, including, but not limited to, cell differentiation and survival. Despite this, the mechanisms underlying this modulation have yet to be unraveled. Here, we assessed the effect of EMFs on intracellular [Ca2+], by exposing HEK 293 cells to both radio-frequency electromagnetic fields (RF-EMFs) and static magnetic fields (SMFs). We detected a constant and significant increase in [Ca2+] subsequent to exposure to both types of fields. Strikingly, the increase was nulled by administration of 10 μM Thapsigargin, a blocker of sarco/endoplasmic reticulum Ca2+ -ATPases (SERCAs), indicating the involvement of the endoplasmic reticulum (ER) in EMF-related modulation of Ca2+ homeostasis.

Open access paper: https://physoc.onlinelibrary.wiley.com/doi/10.14814/phy2.15189

EXTREMELY LOW FREQUENCY MAGNETIC FIELD ENHANCES EXPRESSION OF A SPECIFIC RECOMBINANT PROTEIN IN BACTERIAL HOST

Behnaz Rashidieh, Alireza Madjid Ansari, Mahdi Behdani, Behrad Darvishi, Mahdi Habibi-Anbouhi. Extremely low frequency magnetic field enhances expression of a specific recombinant protein in bacterial host. Anal Biochem. 2022 May 21;114745. doi: 10.1016/j.ab.2022.114745.

Abstract

Expression of proteins in bacterial host cells, particularly E.coli, has gained much attention in recent years. Low expression outcome is the main technical drawback associated with this procedure, further restricting its largescale application in industry. Therefore, application of new amendments or reformations are required before further proceedings. Extremely low frequency magnetic fields (ELF-MFs) have shown to significantly affect biological processes, including gene expression, in E.coli. In current study, we investigated whether application of ELF-MF could result in overexpression of proteins in E.coli or not. Cluster of differentiation-22 (CD22), as a model protein, was expressed in E.Coli Rosetta (DE3) under continuous exposure to ELF-MF after applying various concentrations of Isopropyl ß-d-1-thiogalactopyranoside (IPTG) (0.25-1.25 mM) as inducer. The strength and frequency of electromagnetic fields (EMFs) ranged between 15-100 mT and 2.5-20 Hz respectively. Interestingly, application of 55mT EMFs with frequencies ranging from 2.5 to 2.8 Hz significantly enhanced the yield of expression at all studied IPTG concentrations. Contrarily, EMFs with intensities other than 55 mT meaningfully declined protein expression at IPTG concentrations equal to 1 and 1.25 mM. In conclusion, application of specific range of ELF-MFs may be exploited as a new modification for enhancing heterologous expression of proteins in E.coli.

https://pubmed.ncbi.nlm.nih.gov/35609685/

COMMERCIAL OUTDOOR PLANT NURSERIES AS A CONFOUNDER FOR ELECTROMAGNETIC FIELDS AND CHILDHOOD LEUKEMIA RISK

A Nguyen, C M Crespi, X Vergara, L Kheifets. Environ Res. 2022 May 10;212(Pt C):113446. doi: 10.1016/j.envres.2022.113446.

Highlights

- Close proximity to plant nurseries is a potential childhood leukemia risk factor.
- Proximity to nurseries did not explain distance to power lines and CL associations.
- Proximity to nurseries did not explain magnetic field and CL associations.
- First detailed study of pesticides as a confounder for magnetic fields and CL.

Abstract

Background: Close residential proximity to powerlines and high magnetic fields exposure may be associated with elevated childhood leukemia risks as reported by prior studies and pooled analyses. Magnetic fields exposure from high-voltage powerlines is associated with proximity to these powerlines and consequently with any factor varying with distance. Areas underneath powerlines in California may be sites for commercial plant nurseries that can use pesticides, a potential childhood leukemia risk factor.

Objectives: Assess if potential pesticide exposure from commercial plant nurseries is a confounder or interacts with proximity or magnetic fields exposure from high-voltage powerlines to increase childhood leukemia risk.

Methods: A comprehensive childhood leukemia record-based case-control study with 5788 cases and 5788 controls (born and diagnosed in California, 1986-2008) was conducted. Pesticide, powerline, and magnetic field exposure assessment utilized models that incorporated geographical information systems, aerial satellite images, site visits and other historical information.

Results: The relationship for calculated fields with childhood leukemia (odds ratio (OR) 1.51, 95% confidence interval (CI) 0.70-3.23) slightly attenuated when controlling for nursery proximity (OR 1.43, 95% CI 0.65-3.16) or restricting analysis to subjects living far (>300 m) from nurseries (OR 1.43, 95% CI 0.79-2.60). A similar association pattern was observed between distance to high-voltage powerlines and childhood leukemia. The association between nursery proximity and childhood leukemia was unchanged or only slightly attenuated when controlling for calculated fields or powerline distance; ORs remained above 2 when excluding subjects with high calculated fields or close powerline proximity (OR 2.16, 95% CI 0.82-5.67 and OR 2.15, 95% CI 0.82-5.64, respectively). The observed relationships were robust to different time periods, reference categories, and cut points.

Discussion: Close residential proximity to nurseries is suggested as an independent childhood leukemia risk factor. Our results do not support plant nurseries as an explanation for observed childhood leukemia risks for powerline proximity and magnetic fields exposure, although small numbers of subjects concurrently exposed to high magnetic fields, close powerline proximity and plant nurseries limited our ability to fully assess potential confounding.

Open access paper:
https://www.sciencedirect.com/science/article/pii/S0013935122007733?via%3Dihub

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AN OVERVIEW OF THE BIOLOGICAL EFFECTS OF EXTREMELY LOW FREQUENCY ELECTROMAGNETIC FIELDS COMBINED WITH IONIZING RADIATION

Bahareh Gholipour Hamedani, Bahram Goliaei, Seyed Peyman Shariatpanahi, Maryamsadat Nezamtaheri. An overview of the biological effects of extremely low frequency electromagnetic fields combined with ionizing radiation. Prog Biophys Mol Biol. 2022 May 2;S0079-6107(22)00037-2. doi: 10.1016/j.pbiomolbio.2022.04.008.

Abstract

By growing the electrical power networks and electronic devices, electromagnetic fields (EMF) have become an inseparable part of the modern world. Considering the inevitable exposure to a various range of EMFs, especially at extremely low frequencies (ELF-EMF), investigating the biological effects of ELF-EMFs on biological systems became a global issue. The possible adverse consequences of these exposures were studied, along with their potential therapeutic capabilities. Also, their biological impacts in combination with other chemical and physical agents, specifically ionizing radiation (IR), as a co-carcinogen or as adjuvant therapy in combination with radiotherapy were explored. Here, we review the results of several in-vitro and in-vivo studies and discuss some proposed possible mechanisms of ELF-EMFs' actions in combination with IR. The results of these experiments could be fruitful to develop more precise safety standards for environmental ELF-EMFs exposures. Furthermore, it could evaluate the therapeutic capacities of ELF-EMFs alone or as an improver of radiotherapy. https://pubmed.ncbi.nlm.nih.gov/35513112/

TOXICANT-ASSOCIATED FATTY LIVER DISEASE AND LIVER NEOPLASTIC PROGRESS IN RATS TREATED WITH AFLATOXIN B1 ALONE OR IN COMBINATION WITH EXTREMELY LOW FREQUENCY EMF

Vornoli A, Tibaldi E, Gnudi F, Sgargi D, Manservisi F, Belpoggi F, Tovoli F, Mandrioli D. Toxins (Basel). 2022 May 3;14(5):325. doi: 10.3390/toxins14050325. PMID: 35622572; PMCID: PMC9143281.

Abstract

The term toxicant-associated fatty liver disease (TAFLD) has been proposed to describe fatty liver diseases connected to toxicants other than alcohol. Aflatoxins are mycotoxins commonly found as contaminants in foods and feeds, which are known liver toxicants and potential candidates as potential causes of TAFLD. Aflatoxin B1 (AFB1) was administered at low doses to Sprague-Dawley (SD) rats, alone or in combination with S-50 Hz an extremely low frequency electromagnetic field (ELFEMF), to study the evolution of TAFLD, preneoplastic and neoplastic lesions of the liver and the potential enhancing effect of lifespan exposure to ELFEMF. Steatosis, inflammation and foci of different types were significantly increased in both aflatoxin-treated males and females, which is consistent with a pattern of TAFLD. A significant increase in adenomas, cystic dilation of biliary ducts, hepatocellular hyperplasia and hypertrophy and oval cell hyperplasia were also observed in treated females only. The administration of low doses of AFB1 caused TAFLD in SD rats, inducing liver lesions encompassing fatty infiltration, foci of different types and adenomas. Furthermore, the pattern of change observed in preneoplastic liver lesions often included liver steatosis and steatohepatitis (TASH). ELFEMF did not result in any enhancing or toxic effect in the liver of SD rats.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9143281/

LUNG CELL TOXICITY OF CO-EXPOSURE TO AIRBORNE PARTICULATE MATTER AND EXTREMELY LOW-FREQUENCY MAGNETIC FIELD

Zahra Panjali, Parviz Abdolmaleki, Behnam Hajipour, Omar Hahad, Rezvan Zendehdel. Lung Cell Toxicity of Co- Exposure to Airborne Particulate Matter and Extremely Low-Frequency Magnetic Field. Xenobiotica. 2022 May 24;1-34. doi: 10.1080/00498254.2022.2082342.

Abstract

Although the toxic effects of urban airborne particulate matter (PM) have been known on lung cells, there is less attention to co-exposure to PM and extremely low frequency magnetic (ELF-MF) in occupational settings. The present study investigated the influences of PM and ELF-MF co-exposure on toxicity in human lung cells (A549). In this case, total PM (TPM) was evaluated according to NIOSH-0500. The TPM SiO2 and metal contents were determined based on NIOSH-7602 and 7302, respectively. Besides, 900 mG ELF-MF exposure was simulated based on field measurements. The toxicity mechanisms were assessed by examining malondialdehyde, glutathione ratio, gene expression, and DNA strand breaks. Also, the toxicity indicators of the TPM samples were MDA generation, glutathione depletion, and DNA damage, and their impacts were analyzed at doses below the LD50 (4 µg). In addition, gene expression of OGG1 and MTH1 was upregulated after TPM exposure at the lowest dose (2 µg). But ITPA was upregulated in the presence of ELF-MF. The co-exposure to TPM and ELF-MF decreased oxidative stress and DNA damage levels compared to a single exposure to TPM. Although the ELF-MF reduced toxicity in response to TPM, this reduction was not lower than the unexposed cells.

https://pubmed.ncbi.nlm.nih.gov/35608272/

THE EFFECT OF ELECTROMAGNETIC FIELD (EMF) EXPOSURE ON SYNTHESIS AND RELEASE OF STEROID HORMONES BY THE PORCINE CONCEPTUSES DURING THE PERI-IMPLANTATION PERIOD

Anita Franczak, Ewa Monika Drzewiecka, Wiktoria Kozlowska, Agata Zmijewska, Pawel Jozef Wydorski, Anna Koziorowska. The effect of electromagnetic field (EMF) exposure on synthesis and release of steroid hormones by the porcine conceptuses during the peri-implantation period. Reprod Fertil Dev. 2022 May 2. doi: 10.1071/RD22040.

Abstract

Context: Electrical devices and power systems are the sources of EM-waves which propagate everywhere in the environment.

Aims: The study aimed to determine whether EMF induced changes in the steroidogenesis of conceptuses and whether progesterone (P4) may be a possible protectant against the effects of EMF radiation.

Methods: The entire porcine conceptuses were collected during the peri-implantation period (days 15-16 of pregnancy), divided into fragments (100mg) and treated in vitro with EMF (50Hz or 120Hz, 2 or 4h exposure), and examined to determine of CYP17A1, HSD3B1, CYP19A3, and HSD17B4 mRNA transcript and encoded protein abundance and the release of steroid hormones. Selected fragments of conceptuses were treated with P4.

Key results: In conceptuses incubated without P4, EMF at 120Hz decreased androstenedione (A4) and testosterone (T) release after 2h and increased oestrone (E1) release at 50Hz and 120Hz after 4h exposure. In P4-treated conceptuses, EMF (50 and 120Hz, 4h exposure) decreased CYP19A3 mRNA transcript abundance, and increased (120Hz, 2h exposure) oestradiol-17β (E2) release.

Conclusions: The EMF radiation alters androgen and oestrogen synthesis and release from the conceptuses of pigs during the peri-implantation period. The P4 exerts protective effects on androgens and E1 release but it sensitises the conceptuses when comes to the mechanism of oestrogen synthesis and release during EMF radiation.

Implications: The effect of EMF radiation on the steroidogenic pathway in conceptuses may induce disturbances in their proper development and implantation.
https://pubmed.ncbi.nlm.nih.gov/35491406/

SCRUTINIZING THE IMPACT OF ALTERNATING ELECTROMAGNETIC FIELDS ON MOLECULAR FEATURES OF THE MODEL PLANT ARABIDOPSIS THALIANA

Sonja Michèle Schmidtpott, Saliba Danho, Vijay Kumar, Thorsten Seidel, Wolfgang Schöllhorn, Karl-Josef Dietz. Scrutinizing the Impact of Alternating Electromagnetic Fields on Molecular Features of the Model Plant Arabidopsis thaliana. Int J Environ Res Public Health. 2022 Apr 23;19(9):5144. doi: 10.3390/ijerph19095144.

Abstract

Natural and anthropogenic electromagnetic fields (EMFs) are ubiquitous in the environment and interfere with all biological organisms including plants. Particularly the quality and quantity of alternating EMFs from anthropogenic sources are increasing due to the implementation of novel technologies. There is a significant interest in exploring the impact of EMFs (similar to those emitted from battery chargers of electric cars) on plants. The model plant Arabidopsis thaliana was exposed to a composite alternating EMF program for 48 h and scrutinized for molecular alterations using photosynthetic performance, metabolite profiling, and RNA sequencing followed by qRT-PCR validation. Clear differences in the photosynthetic parameters between the treated and control plants indicated either lower nonphotochemical quenching or higher reduction of the plastoquinone pool or both. Transcriptome analysis by RNA sequencing revealed alterations in transcript amounts upon EMF exposure; however, the gene ontology groups of, e.g., chloroplast stroma, thylakoids, and envelope were underrepresented. Quantitative real-time PCR validated deregulation of some selected transcripts. More profound were the readjustments in metabolite pool sizes with variations in photosynthetic and central energy metabolism. These findings together with the invariable phenotype indicate efficient adjustment of the physiological state of the EMF-treated plants, suggesting testing for more challenging growth conditions in future experiments.

Conclusions

EMF exposure occurs ubiquitously on Earth and is a regular environmental parameter all life forms have to deal with. Anthropogenic alternating and rapidly changing EMF emission accentuate the requirement to research the EMF–life and, as conducted here, EMF–plant interaction. The data show that alternating EMF-exposed plants undergo significant alterations at the levels of photosynthesis, transcriptome, and metabolome. The underlying

perception and response mechanisms to weak EMF still need deeper scrutiny and could involve changes in cell signaling, e.g., by interfering with Ca2+ fluxes and concentrations [57]. The changes in photosynthetic features are remarkable particularly since the gross growth parameters were unaltered. A profound metabolic readjustment was detectable upon EMF exposure that would merit further experiments, both in the context of photosynthesis and respiratory energy metabolism. The growth conditions with about 5% of full sunlight (100 µmol photons.m−2 s−1) might not be ideal to work out possible negative effects of the EMF treatment on plant performance. In future experiments, it would be worthwhile to combine such EMF treatments with challenging growth conditions, e.g., by growth in saturating light or combinatorial stress applications [58]. Future experiments could also include the study of early development such as seed germination and seedling establishment similar to [57].
Open access paper: https://www.mdpi.com/1660-4601/19/9/5144

PRUSSIAN BLUE TECHNIQUE IS PRONE TO YIELD FALSE NEGATIVE RESULTS IN MAGNETORECEPTION RESEARCH

Franziska Curdt, Katrin Haase, Laura Ziegenbalg, Helena Greb, Dominik Heyers, Michael Winklhofer. Prussian blue technique is prone to yield false negative results in magnetoreception research. Sci Rep. 2022 May 25;12(1):8803. doi: 10.1038/s41598-022-12398-9.

Abstract

Perls's Prussian blue staining technique has been used in magnetoreception research to screen tissues for iron- rich structures as proxies for putative magnetoreceptor structures based on magnetic particles. However, seemingly promising structural candidates in the upper beak of birds detected with Prussian blue turned out to be either irreproducible or located in non-neuronal cells, which has spurred a controversy that has not been settled yet. Here we identify possible pitfalls in the previous works and apply the Prussian blue technique to tissues implicated in magnetic-particle-based magnetoreception, in an effort to reassess its suitability for staining single-domain magnetite, i.e., the proposed magnetic substrate for the interaction with the external magnetic field. In the upper beak of night-migratory songbirds, we found staining products in great numbers, but not remotely associated with fiber terminals of the traced ophthalmic branch of the trigeminal nerve.

Surprisingly, staining products were absent from the lamina propria in the olfactory rosette of rainbow trout where candidate magnetoreceptor structures were identified with different techniques earlier. Critically, magnetosome chains in whole cells of magnetotactic bacteria remained unstained. The failure to label single- domain magnetite in positive control samples is a serious limitation of the technique and suggests that two most influential but antipodal studies conducted previously stood little chances of obtaining correct positive results under the assumption that magnetosome-like particles were present in the tissues. Nonetheless, the staining technique appears suitable to identify tissue contamination with iron-rich fine dust trapped in epithelia already in vivo.

https://pubmed.ncbi.nlm.nih.gov/35614116/

EFFECTS OF PRE AND POSTNATAL 2450 MHZ CONTINUOUS WAVE (CW) RADIOFREQUENCY RADIATION ON THYMUS: FOUR GENERATION EXPOSURE

Fazile Cantürk Tan, Betül Yalçin, Arzu Hanım Yay, Burak Tan, Korkut Yeğin, Süleyman Daşdağ. Effects of pre and postnatal 2450 MHz continuous wave (CW) radiofrequency radiation on thymus: Four generation exposure. Electromagn Biol Med. 2022 May 30;1-10. doi: 10.1080/15368378.2022.2079673.

Abstract

This study aims to investigate the effects of pre- and postnatal 2450 MHz continuous wave (CW) radiofrequency radiation (RFR) on the thymus of rats spanning four generations. Four groups; sham, irradiated female, irradiated male, irradiated male and female, each consisting of four rats (one male and three females), were created. During the experiment, rats in the exposure groups were whole-body exposed to 2450 MHz CW-RFR for 12 h/day. Irradiation started one month before the fertilization in the experimental group. When the offspring were two months old, four rats, one male and three female, were allocated for the second-generation study.

The remaining offspring were sacrificed under general anesthesia, and their thymuses were removed. The same procedure was applied to the next generation. Two months after the second generation gave birth, third- generation rats were decapitated, and their thymuses were removed. In all groups, cortex, medulla and resident cells could be clearly distinguished in the second and third generations. No differences were observed between the control and two experimental groups, defined as irradiated female and irradiated male. In contrast, vascularization was observed in the thymus of the fourth-generation offspring of the group where both males and females were irradiated. The number of offspring and mass of all rats decreased in the third-generation group. Pre-and postnatal 2450 MHz continuous wave radiofrequency radiation exposure may potentially affect the thymus of future generations.

https://pubmed.ncbi.nlm.nih.gov/35635232/

EFFECT OF AN EXTREMELY LOW-FREQUENCY ELECTROMAGNETIC FIELD ON THE CONCENTRATION OF SALIVARY IMMUNOGLOBULIN A

Piotr Skomro, Danuta Lietz-Kijak, Olga Bogdziewicz-Wałęsa, Joanna Janiszewska-Olszowska. Effect of an Extremely Low-Frequency Electromagnetic Field on the Concentration of Salivary Immunoglobulin A. Int J Environ Res Public Health. 2022 May 10;19(10):5786. doi: 10.3390/ijerph19105786.

Abstract

Extremely Low-Frequency Electromagnetic Field (ELF MF) therapy is effective in the treatment of injury, inflammation and postoperative complications. Its clinical applications relate to bone unification, pain reduction, soft tissue oedema and the decrease of electric potentials in the oral cavity. It enhances regeneration of periapical bone lesions. It is obvious that cells (leukocytes, platelets, keratinocytes, osteoblasts) and proteins (fibrin, collagen, elastin and growth factors) exhibit alterations when exposed to an Extremely Low-Frequency Electromagnetic Field. The aim of the study was to evaluate the effect of an Extremely Low-Frequency Electromagnetic Field (ELF MF) on the parotid gland on the concentration of salivary immunoglobulin A. The study group consisted of 24 patients, aged 14-16, who underwent ELF MF on the parotid gland region. The control group comprised 25 matching

persons. The IgA concentration in saliva samples was established using radial immunodiffusion. Following ELF MF, a statistically significant increase in the concentration of secretory immunoglobulin A was found in the study group, whereas in the control group, no statistically significant differences were noted. It can be concluded that an Extremely Low-Frequency Electromagnetic Field increases the activity of the immune system of the parotid gland.
Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9141657/

INTERFERENCE THRESHOLDS FOR ACTIVE IMPLANTABLE CARDIOVASCULAR DEVICES IN OCCUPATIONAL LOW-FREQUENCY ELECTRIC AND MAGNETIC FIELDS: A NUMERICAL AND IN VITRO STUDY

Zhou M, Kourtiche D, Claudel J, Deschamps F, Magne I, Roth P, Schmitt P, Souques M, Nadi M. Interference thresholds for active implantable cardiovascular devices in occupational low-frequency electric and magnetic fields: a numerical and in vitro study. Med Eng Phys. 2022 Jun;104:103799. doi: 10.1016/j.medengphy.2022.103799.

Abstract

In light of concerns regarding the occupational safety and health of workers wearing active implantable medical devices (AIMDs), this study aims to investigate the potential risks of electromagnetic interference (EMI) between AIMDs and low-frequency 50/60 Hz electromagnetic fields (EMFs) in the workplace. A total of 58 AIMDs, consisting of pacemakers (PMs) and implantable cardiac defibrillators (ICDs) of different brands, models, and configurations were tested to determine the immunity thresholds for high-voltage electric fields (EFs) and magnetic fields (MFs) at 50/60 Hz. The EFs and MFs at the levels in workplaces are reproduced by setups using Helmholtz coils and aluminum plates, respectively, to ensure that the EM/MF exposures are controllable and reproducible. The EMI thresholds were recorded by observing the occurrences of PM or ICD dysfunctions. In addition, numerical studies on anatomical models were carried out using CST® software. The results indicate that the recorded thresholds all exceed the EF and MF public exposure limits given in the ICNIRP 2010 guidelines. No dysfunction was observed among four ICDs tested under MF exposure up to 2750 µT at 50 Hz and 2480 µT at 60 Hz. However, among the 43 PMs and 11 ICDs tested under EF exposures, potential hazards may occur below the occupational exposure level proposed in the ICNIRP guidelines.
https://pubmed.ncbi.nlm.nih.gov/35641069/

HUMAN MAGNETIC SENSE IS MEDIATED BY A LIGHT AND MAGNETIC FIELD RESONANCE-DEPENDENT MECHANISM

Kwon-Seok Chae, Soo-Chan Kim, Hye-Jin Kwon, Yongkuk Kim. Human magnetic sense is mediated by a light and magnetic field resonance-dependent mechanism. Sci Rep. 2022 May 30;12(1):8997. doi: 10.1038/s41598-022- 12460-6.

Abstract

Numerous organisms use the Earth's magnetic field as a sensory cue for migration, body alignment, or food search. Despite some contradictory reports, yet it is generally accepted that humans do not sense the geomagnetic field. Here, we demonstrate that a magnetic field resonance mechanism mediates light-dependent magnetic orientation in men, using a rotary chair experiment combined with a two-alternative forced choice paradigm. Two groups of

subjects were classified with different magnetic orientation tendencies depending on the food context. Magnetic orientation of the subjects was sensitive to the wavelength of incident light and was critically dependent on blue light reaching the eyes. Importantly, it appears that a magnetic field resonance- dependent mechanism mediates these responses, as evidenced by disruption or augmentation of the ability to orient by radiofrequency magnetic fields at the Larmor frequency and the dependence of these effects on the angle between the radiofrequency and geomagnetic fields. Furthermore, inversion of the vertical component of the geomagnetic field revealed a non-canonical inclination compass effect on the magnetic orientation. These results establish the existence of a human magnetic sense and suggest an underlying quantum mechanical magnetoreception mechanism.
Open access paper: https://www.nature.com/articles/s41598-022-12460-6

THE ROLES OF INTENSITY, EXPOSURE DURATION, AND MODULATION ON THE BIOLOGICAL EFFECTS OF RADIOFREQUENCY RADIATION AND EXPOSURE GUIDELINES

Henry Lai, B. Blake Levitt. The roles of intensity, exposure duration, and modulation on the biological effects of radiofrequency radiation and exposure guidelines. Electromagn Biol Med. 2022 Apr 19:1-26. doi: 10.1080/15368378.2022.2065683.

Abstract

In this paper, we review the literature on three important exposure metrics that are inadequately represented in most major radiofrequency radiation (RFR) exposure guidelines today: intensity, exposure duration, and signal modulation. Exposure intensity produces unpredictable effects as demonstrated by nonlinear effects. This is most likely caused by the biological system's ability to adjust and compensate but could lead to eventual biomic breakdown after prolonged exposure. A review of 112 low-intensity studies reveals that biological effects of RFR could occur at a median specific absorption rate of 0.0165 W/kg. Intensity and exposure duration interact since the dose of energy absorbed is the product of intensity and time. The result is that RFR behaves like a biological "stressor" capable of affecting numerous living systems. In addition to intensity and duration, man-made RFR is generally modulated to allow information to be encrypted. The effects of modulation on biological functions are not well understood. Four types of modulation outcomes are discussed. In addition, it is invalid to make direct comparisons between thermal energy and radiofrequency electromagnetic energy. Research data indicate that electromagnetic energy is more biologically potent in causing effects than thermal changes. The two likely function through different mechanisms. As such, any current RFR exposure guidelines based on acute continuous-wave exposure are inadequate for health protection.

Excerpts

"Over the last 25–30 years, significant information has been published that in other regulated areas would have resulted in re-examination and adjustments to allowable exposure limits. This has not been the case with these two groups [the FCC and ICNIRP] which adhere to a model based on obsolete scientific evidence, especially in light of the new 5G network that uses higher frequencies and novel modulation forms that have never been used before in broad civilian telecommunications and which are poorly studied."

"RFR effects have been observed at low intensities (< 0.4 W/kg) – a list of which is included in Supplement 1 – far below the guidelines. This points to both the nonlinearity of how living

systems couple with nonionizing radiation as well as the inadequacy of acute thresholds. The studies encompass many different biological effects to myriad systems, including: apoptosis induction, adrenal gland activity, blood–brain barrier permeability, brain transmitter levels, calcium concentration in heart muscle, calcium efflux, calcium movement in cells, cell growth, cognitive functions, cellular damage in liver, decreased cell proliferation, embryonic development, endocrine changes, enolose activity, genetic effects, hippocampal neuronal damage, immunological functions, kidney development, memory functions, latency of muscular contraction, membrane chemistry, nerve cell damage, metabolic changes, neural electrical activity, oxidative stress, plant growth, prion level, protein changes, renal injury, serum testosterone concentration, heat-shock protein induction, testis morphology, testosterone synthesis, thymidine incorporation, and ultrastructural alteration in cell cytoplasm. In fact, there are not many physiological functions in humans, animals, or plants that are not affected by low-level RFR."

"As reflected in Supplement 1, SARs at which effects were observed were available from 112 studies. Of these, 75 (67%) were in vivo exposure studies with whole body/organ SARs available. The other 37 (33%) studies were in vitro experiments The level at which biological effects occur represents data from in vivo and in vitro and acute and chronic/repeated-exposure experiments. There is a very wide range of effects seen. With an exposure that induces a SAR of 0.0165 W/kg, and using a ten-fold protection, the SAR would be 0.00165 W/kg (i.e., 1.65 mW/kg). For rate of energy absorption in body organs, 0.00165 W/kg is far below the maximum level allowed in the guidelines (whether over 1 or 10 gm of tissue as per FCC/ICNIRP allowances). Given the large body of work as illustrated in Supplement 1, the SAR at, or below, 4 W/kg as a safe threshold is insupportable."

"The duration of exposure is another important factor in biological effects. Other than demarcations for whole body exposures averaged over 30 minutes and local body areas averaged over 6 minutes, neither FCC nor ICNIRP address duration, especially pertaining to long-term and low-level RFR exposures. These are prevalent in both near-field exposures to people with WiFi routers, for example, as well as cell phones, and far-field exposures from infrastructure that have created chronic rising ambient background levels (Levitt et al. 2021a). The guidelines are written only for short-term acute durations. What we do know is that the supposition that all exposures are the same above and below the SAR threshold set by FCC/ICNIRP is fundamentally flawed in light of the most current research. One feasible and logical solution to such uncertainties regarding duration as an exposure factor would be to adopt an SAR level commensurate with the studies summarized in Supplement 1 at no higher than 0.00165 W/kg, no matter the exposure conditions."

"It is generally believed that modulated RFR is more biologically active than continuous-wave (CW) radiation, i.e., the carrier-wave. To understand the biological and possible hazardous health effects of RFR, it is therefore important to understand modulation effects. Below we discuss what is known about modulation from the research literature (mostly from 1990 to date) and examine the claim that modulation makes RFR more biologically significant.

There is research showing no significant biological effects of CW-RFR (Table 1a) but there are also studies that reported CW-RFR effects too (Table 1b). The reason why CW-RFR produced effects in some studies but not others is unknown. Both types of studies (with “effect” and

“no effect” outcomes) involved many different biological endpoints, exposure intensities, and duration of exposure – with no discernible differences. A possible explanation is that different tissue types respond differently to CW-RFR. But that just adds another level of inquiry. One of the most puzzling observations is when CW caused an effect but modulation did not (e.g., Kubinyi et al. 1996; Luukkonen et al. 2009). In some studies, a modulated field produced an effect that was not produced by CW. These observations may indicate that the CW carrier-wave itself and modulation act on different mechanisms Differences in responses between CW and modulated fields of the same frequency and incident power density provide strong proof that non-thermal effects occur since the two conditions should produce the same amount of heating. Some studies reported that differentfrequencies of modulation caused different biological responses CW and modulated fields can cause the same effects but with different degrees of biological activity and intensity of reactions. In most instances, a modulated field was found to be more potent than CW versus only one study in which the opposite was reported (Persson et al. 1997) To add to the complexities described above, effects with modulated fields have also been shown to depend on exposure duration there are many studies that used intermittent exposure (e.g., 10 min ON/10 min OFF) instead of continuous exposure with the supposition that intermittent exposure is more biologically active. But not much data showed this to be true There are many studies using pulsed fields (i.e., mobile phone signals are pulsed), but there are not many studies that compared pulsed and CWfields of the same SAR in the same study. However, there are reports that effects only occurred with a pulsed field but not CW.... there are many studies showing effects of RFR on the hippocampus "

"Oxidative changes and stress have been reported in many papers on exposure to electromagnetic fields (Lai 2020; Yakymenko et al. 2016). These are the most consistent cellular responses to RFR exposure. Mechanisms have been proposed to account for oxidative effects that may involve the low-frequency component of modulation (e.g., see Barnes and Greenebaum 2015; Castello et al. 2021) But there is not enough data to conclude that modulation effects are caused by oxidative processes. In fact some effects of CW exposure alone also found changes in free radical mechanisms."

"It is important to point out as significant proof of non-thermal RFR effects that CW and modulated-waves of the same frequency and incident power density can/and do produce different effects. The bottom line is that certainty is elusive regarding precise effects in all circumstances. What is clear is that both modulation and continuous-wave RFR are biologically active and both should be considered in exposure guidelines. In situations where enough evidence exists to warrant specific caution, such as with pulsed fields used in cell phones and phased modulation with 5G, particular attention should be paid to include modulation in the guidelines beyond the suppositions of safety contained within the safety allowances. Peak exposures must also be factored in and not just the averaged values which only hide their significance."

"It is apparent that the biological outcome of changing the intensity and duration of RFR exposure is basically unpredictable. This is mainly due to the complex nature of the biological system studied. Intensity and duration can interact and produce different response patterns as shown in the literature reviewed above.

It is also apparent that how RFR modulation affects biological functions is difficult to quantify. Observed effects are multi-variant and involve many factors such as intensity, carrier frequencies and modulation, the modulation waveform itself, exposure duration, and properties of the exposed object. Not enough research data are presently available to provide an explanation or prediction of modulation effects under all circumstances. It may also turn out that modulation is of little major health concern or conversely that it is the only factor that matters– evidence is thus far too contradictory regarding modulation's ability to consistently enhance the biological effects of carrier-waves. Then again, with most modulation forms the carrier-wave is completely altered. All of this awaits proper investigation with comparison studies. In the meantime, there are legitimate reasons for concern, given the contradictions in the literature.

In general, anthropogenic RFR – with highly unusual waveform characteristics and intensities that do not exist in the natural world – is new to the environment and thus has not been a factor in the evolution of species. Living organisms evolved over millions of years in the presence of static and extremely-low frequency (ELF) electromagnetic fields. These fields play critical roles in their survival, e.g., in migration, food foraging, and reproduction, etc. (see Levitt et al. 2021b). Living organisms are extremely sensitive to the presence of these environmental fields and thus, they can easily be disturbed by man-made EMF. RFR probably acts upon and modifies these primordial EMFs and affects biological functions. Interactions of static/ELF EMF and RFR are basically not well studied, not to mention the mechanisms of involvement of RFR modulations. The interactions are inevitably complex. Such interaction studies would provide answers to wildlife effects.

Regarding the perennial thermal- versus non-thermal- effects criticism inherent in human RFR exposure guidelines, it must be said that the underlying mechanisms of effects should not be a matter of concern in setting of exposure guidelines as is common today. What is important is the level at which energy absorption causes an effect. One such powerful proof – among so very many others – of non-thermal effects is evidenced in the fact that CW and modulated-waves of the same frequency and incident power density can produce different effects, as seen in the modulation section of this paper and Table 2."

"When effects continue to be observed over a long period of time that go against prevailing beliefs, even when mechanisms remain imperfectly understood, the appropriate course of regulatory action is to examine the underlying basis upon which an original premise was formed. When proven incomplete or invalid by new information, the change in a regulatory course is not only justified but is imperative. Disproven or incomplete deductions of how RFR affects living cells and tissues, as well as suppositions of safety for exposed individuals and the environment are insupportable given the wealth of studies to draw from today that have filled in many gaps. We need to more responsibly address the increasing near- and far-field RFR exposures of contemporary life with an eye toward 5G technology's unique characteristics. A new conceptual framework is called for."
https://www.tandfonline.com/doi/full/10.1080/15368378.2022.2065683

ESTIMATION OF RF AND ELF DOSE BY ANATOMICAL LOCATION IN THE BRAIN FROM WIRELESS PHONES IN THE MOBI-KIDS STUDY

Carolina Calderón, Gemma Castaño-Vinyals, Myron Maslanyj, Joe Wiart, Ae-Kyoung Lee, Masao Taki, Kanako Wake, Alex Abert, Francesc Badia, Abdelhamid Hadjem, Hans Kromhout, Patricia de Llobet, Nadège Varsier, Emmanuelle Conil, Hyung-Do Choi, Malcolm R. Sim, Elisabeth Cardis. Estimation of RF and ELF dose by anatomical location in the brain from wireless phones in the MOBI-Kids study. Environment International. 163. 2022. 107189. doi:10.1016/j.envint.2022.107189.

Highlights

- Epidemiological studies on mobile phone radiation typically rely on phone use history.
- MOBI-Kids is the first study to estimate RF and ELF dose from wireless phones.
- RF and ELF doses vary by age, phone model, communication system and amount of use.
- Communication system and location in the brain are key determinants of dose.
- Duration and number of calls are likely to be crude proxies of dose.

Abstract

Wireless phones (both mobile and cordless) emit not only radiofrequency (RF) electromagnetic fields (EMF) but also extremely low frequency (ELF) magnetic fields, both of which should be considered in epidemiological studies of the possible adverse health effects of use of such devices. This paper describes a unique algorithm, developed for the multinational case-control MOBI-Kids study, that estimates the cumulative specific energy (CSE) and the cumulative induced current density (CICD) in the brain from RF and ELF fields, respectively, for each subject in the study (aged 10–24 years old). Factors such as age, tumour location, self-reported phone models and usage patterns (laterality, call frequency/duration and hands-free use) were considered, as was the prevalence of different communication systems over time. Median CSE and CICD were substantially higher in GSM than 3G systems and varied considerably with location in the brain. Agreement between RF CSE and mobile phone use variables was moderate to null, depending on the communication system. Agreement between mobile phone use variables and ELF CICD was higher overall but also strongly dependent on communication system. Despite ELF dose distribution across the brain being more diffuse than that of RF, high correlation was observed between RF and ELF dose. The algorithm was used to systematically estimate the localised RF and ELF doses in the brain from wireless phones, which were found to be strongly dependent on location and communication system. Analysis of cartographies showed high correlation across phone models and across ages, however diagonal agreement between these cartographies suggest these factors do affect dose distribution to some level. Overall, duration and number of calls may not be adequate proxies of dose, particularly as communication systems available for voice calls tend to become more complex with time.

Conclusion

This paper describes the algorithm constructed to assess the localised RF and ELF dose arising from the use of mobile (cellular) and DECT (cordless) phones in the MOBI-Kids study. The algorithm was based on information on phone use provided by study subjects, on information from operators on prevalence of communication systems as a function of time, on RF and ELF modelling performed as part of the exposure assessment work package (which considered

morphological changes due to age), and on validation studies performed within the overall study. ELF and RF dose diminished rapidly with increasing depth, demonstrating location in the brain is an important variable in dose estimation. The agreement between CSE and phone use variables varied by communication system; it was highest for GSM and close to 0 for UMTS and CDMA. Higher agreement was observed between CICD and phone use variables, but agreement was still close to 0 for 3G systems. Analysis of cartographies showed high correlation across phone models and across ages, however diagonal agreement between these cartographies suggest these factors do affect dose distribution to some level and should thus be ideally considered. Overall, the results highlight the importance of considering the effect of communication system and anatomical location in estimating dose and suggests phone use is becoming a poorer exposure proxy as communication systems available for voice calls tend to become more complex with time.
https://www.sciencedirect.com/science/article/pii/S0160412022001155

EFFECTS OF MOBILE PHONE USE ON SEMEN PARAMETERS: A CROSS-SECTIONAL STUDY OF 1634 MEN IN CHINA

Shanshan Zhang, Fengyi Mo, Yali Chang, Shufang Wu, Qing Ma, Fan Jin, Lanfeng Xing. Effects of mobile phone use on semen parameters: a cross-sectional study of 1634 men in China. Reprod Fertil Dev. 2022 Apr 19. doi: 10.1071/RD21234.

Abstract

Mobile phones play an irreplaceable role in modern people's lives. However, the radiofrequency electromagnetic radiation produced by mobile phones has also caused increasing concern. A cross-sectional study was conducted to investigate the effect of radiofrequency electromagnetic radiation produced by mobile phones on semen parameters in 1634 men who underwent semen examination at the Department of Reproductive Endocrinology, Women's Hospital, School of Medicine, Zhejiang University, China. Analysis of variance and multivariate linear regression were used to explore differences among different groups. A $P<0.05$ was considered statistically significant. The results showed significant associations among different groups of daily mobile phone use time and daily duration of phone calls in the percentage of progressively motile spermatozoa ($P=0.004$ and $P=0.007$), rapid progressively motile spermatozoa ($P=0.012$ and $P=0.006$) and total motile spermatozoa ($P=0.004$ and $P=0.046$). After adjustments for the confounding effects of age and body mass index by multiple linear regression, the results showed that the daily duration of mobile phone use had a negative effect on sperm motility. However, there was no statistically significant correlation between daily phone call duration and sperm motility. Therefore, the daily duration of mobile phone use may negatively affect sperm motility and impair male fertility.

Conclusion

Our results suggest that the average daily cell phone use duration may affect sperm motility to some extent, leading to a decrease in sperm motility. Therefore, we recommend that men of reproductive age avoid prolonged durations of using mobile phones. In addition, more well-designed cross-sectional investigations and mechanistic studies are needed in the future to clarify the effects of RF-EMR produced by mobile phones on male semen quality.
Open access paper: https://www.publish.csiro.au/rd/RD21234

EFFECT OF DURATION OF MOBILE PHONE USE ON THE SALIVARY FLOW AND TOTAL ANTIOXIDANT CAPACITY OF SALIVA AND SALIVARY IMMUNOGLOBULIN A LEVEL

Bansal D, Chhaparwal Y, Pai KM, Kumar M, Vineetha R, Chhaparwal S, Kamath S, Kamath A. Effect of Duration of Mobile Phone Use on the Salivary Flow and Total Antioxidant Capacity of Saliva and Salivary Immunoglobulin A Level: A Cross-sectional Study. J Int Soc Prev Community Dent. 2022 Apr 8;12(2):260-265. doi: 10.4103/jispcd.JISPCD_361_21.

Abstract

Introduction: The objective of this study was to observe the effects of the duration of handheld mobile phone usage on the salivary flow, salivary immunoglobulin A (IgA) level, and salivary markers for oxidative stress.

Materials and methods: Eighty-one students were categorized into three groups based on their duration of mobile phone usage after age- and gender-matching. Students were grouped as: mobile phone usage <20 min/day (Group A), mobile phone usage 20-60 min/day (Group B), and mobile phone usage >60 min/day (Group C). Saliva was collected to evaluate salivary flow rate, salivary IgA level, and salivary markers for oxidative stress.

Results: The salivary flow rate showed no statistically significant difference between the three groups (P = 0.180). There was no statistically significant difference in the salivary IgA between the three groups (P = 0.237). There was a statistically significant difference in the malondialdehyde (MDA) level between the three groups (P
= 0.042). On pair comparison between the groups, group B and group C had a statistically significant difference (P = 0.019) in the MDA level. There was no statistically significant difference in the salivary thiol level between the three groups (P = 0.237).

Conclusion: The duration of handheld mobile phone usage did not show any significant effects on the salivary flow rate, salivary IgA, and thiol levels. There was an increase in the salivary MDA concentration in subjects using handheld mobile phones for a longer duration, indicating higher oxidative stress in salivary glands exposed to mobile phone radiofrequency electromagnetic waves for a longer duration.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9022387/

ROLE OF 2.4 GHZ RADIOFREQUENCY RADIATION EMITTED FROM WI-FI ON SOME MIRNA AND FATTY ACIDS COMPOSITION IN BRAIN

Suleyman Dasdag, Mehmet Zulkuf Akdag, Mehmet Bashan, Veysi Kizmaz, Nurten Erdal, Mehmet Emin Erdal, Mehmet Tughan Kiziltug, Korkut Yegin. Role of 2.4 GHz radiofrequency radiation emitted from Wi-Fi on some miRNA and faty acids composition in brain. Electromagn Biol Med. 2022 Apr 17;1-12. doi: 10.1080/15368378.2022.2065682.

Abstract

The purpose of this study is to investigate the effects of 2.4 GHz Wi-Fi exposure, which is continuously used in the internet connection by mobile phones, computers and other wireless equipment, on microRNA and membrane and depot fatty acid composition of brain cells. Sixteen Wistar Albino rats were divided equally into two groups such as sham and exposure. The rats in the experimental group (n = 8) were exposed to 2.4 GHz RFR emitted from a Wi-Fi

generator for 24 h/day for one year. The animals in the control group (n = 8) were kept under the same conditions as the experimental group, but the Wi-Fi generator was turned off. At the end of the study, rats were sacrificed and brains were removed to analyze miRNA expression and membrane and depot fatty acids of brain cells. We analyzed the situation of ten different miRNA expressions and nineteen fatty acid patterns in this study. We observed that long-term and excessive exposure of 2.4 GHz Wi-Fi radiation increased rno-miR-181a-5p, phosphatidylserine (PS) and triacylglycerol (TAG) in the brain. In conclusion, 2.4 GHz Wi-Fi exposure has the potential to alter rno-miR-181a-5p expression and the fatty acid percentage of some membrane lipids such as phospholipid (PL), phosphatidylserine (PS) and triacylglycerol (TAG), which are depot fats in the brain. However, the uncontrolled use of RFRs, whose use and diversity have reached incredible levels with each passing day and which are increasing in the future, may be paving the way for many diseases that we cannot connect with today.
https://pubmed.ncbi.nlm.nih.gov/35435088/

EVIDENCE BASE ON THE POTENTIAL CARCINOGENICITY OF RADIOFREQUENCY RADIATION

Grimes DR. Radiofrequency Radiation and Cancer: A Review. JAMA Oncol. 2022 Mar 1;8(3):456-461. doi: 10.1001/jamaoncol.2021.5964. Erratum in: JAMA Oncol. 2022 Apr 21;: PMID: 34882171.

Abstract

Importance: Concerns over radiofrequency radiation (RFR) and carcinogenesis have long existed, and the advent of 5G mobile technology has seen a deluge of claims asserting that the new standard and RFR in general may be carcinogenic. For clinicians and researchers in the field, it is critical to address patient concerns on the topic and to be familiar with the existent evidence base.

Observations: This review considers potential biophysical mechanisms of cancer induction, elucidating mechanisms of electromagnetically induced DNA damage and placing RFR in appropriate context on the electromagnetic spectrum. The existent epidemiological evidence in humans and laboratory animals to date on the topic is also reviewed and discussed.

Conclusions and relevance: The evidence from these combined strands strongly indicates that claims of an RFR- cancer link are not supported by the current evidence base. Much of the research to date, however, has been undermined by methodological shortcomings, and there is a need for higher-quality future research endeavors. Finally, the role of fringe science and unsubstantiated claims in patient and public perception on this topic is highly relevant and must be carefully considered. https://pubmed.ncbi.nlm.nih.gov/34882171/

Critical responses:

- Carpenter DO, Hardell L, Sage C. Evidence Base on the Potential Carcinogenicity of Radiofrequency Radiation. JAMA Oncol. 2022 Apr 21. doi: 10.1001/jamaoncol.2022.0928. https://pubmed.ncbi.nlm.nih.gov/35446341/
- Jooyan N, Mortazavi SM. Evidence Base on the Potential Carcinogenicity of Radiofrequency Radiation. JAMA Oncol. 2022 Apr 21. doi: 10.1001/jamaoncol.2022.0931. https://pubmed.ncbi.nlm.nih.gov/35446369/

- Naidenko OV. Evidence Base on the Potential Carcinogenicity of Radiofrequency Radiation. JAMA Oncol. 2022 Apr 21. doi: 10.1001/jamaoncol.2022.0925. https://pubmed.ncbi.nlm.nih.gov/35446371/
- Moskowitz JM. Why did JAMA Oncology publish a paper written by a Telecom industry spokesperson? Electromagnetic Radiation Safety. 2022 Jan 21. https://bit.ly/GrimesRebuttal
- EHT. Wireless Industry Spokesperson Pens Article on Wireless Health Effects for Top Academic Journal. Environmental Health Trust. 2022 Jan 18. https://ehtrust.org/wireless-industry-spokesperson-pens-article-on- wireless-health-effects-for-top-academic-journal/
- Author's response to criticism: Grimes DR. Evidence Base on the Potential Carcinogenicity of Radiofrequency Radiation-Reply. JAMA Oncol. 2022 Apr 21. doi: 10.1001/jamaoncol.2022.0934. https://pubmed.ncbi.nlm.nih.gov/35446368/

THE MICROWAVE AUDITORY EFFECT

James C. Lin. The Microwave Auditory Effect. IEEE Journal of Electromagnetics, RF and Microwaves in Medicine and Biology. 6(1):16-28. March 2022. doi: 10.1109/JERM.2021.3062826.

Abstract

The microwave auditory effect has been widely recognized as one of the most interesting and significant biological phenomena from microwave exposure. The hearing of pulsed microwaves is a unique exception to sound waves encountered in human auditory perception. The hearing of microwave pulses involves electromagnetic waves. This paper reviews the research in humans and animals leading to scientific documentations that absorption of a single microwave pulse impinging on the head may be perceived as an acoustic zip, click, or knocking sound. A train of microwave pulses may be sensed as buzz, chirp, or tune by humans. It describes neurophysiological, psychophysical, and behavioral observations from laboratory studies involving humans and animals. Mechanistic studies show that the microwave pulse, upon absorption by tissues in the head, launches a pressure wave that travels by bone conduction to the inner ear, where it activates the cochlear receptors via the same process involved for normal sound hearing. Depending on the impinging microwave pulse powers, the level of induced sound pressure could be considerably above the threshold of auditory perception to cause tissue injury. The microwave auditory effects and associated pressures could potentially render damage to brain tissue to cause lethal or nonlethal injuries.

Open access paper:

https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9366412&isnumber=9716150

THE EFFECT OF MOBILE PHONE USE AT NIGHT ON THE SLEEP OF PRE-ADOLESCENT, EARLY ADOLESCENT, AND LATE ADOLESCENT CHILDREN: A STUDY OF 252,195 AUSTRALIAN CHILDREN

Valentina Salcedo Correa, Stephanie Centofanti, Jillian Dorrian, Andrew Wicking, Peter Wicking, Kurt Lushington. The effect of mobile phone use at night on the sleep of pre-adolescent (8-11 year), early adolescent (12-14 year) and late adolescent (15-18 year) children: A study of 252,195 Australian children. Sleep Health. 2022 Apr 8;S2352-7218(22)00015-8. doi: 10.1016/j.sleh.2022.02.004.

Abstract

Objectives: To examine whether the association previously reported between mobile phone use at night and poor sleep in adolescents also generalizes to pre-adolescent children.

Design: Cross sectional.

Participants: Survey completed by 84,915 pre-adolescent (8-11 years), 99,680 early adolescent (12-14 years) and 67,600 late adolescent Australian children (15-18 years).

Measurement: Children were asked how frequently they obtained 8 hours of sleep on most nights and if they used their mobile phone at night to send and receive messages between 10 PM and 6 AM. Binary logistic regression analyses were used to examine the association between mobile phone use at night and sleeping 8h or more on most nights with gender, socioeconomic status and year of study (2014-2018) as covariates.

Results: For all age cohorts including pre-adolescent children, mobile phone use at night was associated with lower odds of obtaining 8 hours of sleep on most nights.

Conclusion: The present findings confirm that the association between mobile phone use at night and poor sleep previously reported in adolescent children also generalises to pre-adolescent children. Given the increased uptake of smartphone devices in ever younger children the findings point to the need to provide parents, schools and communities with resources to promote child sleep hygiene and media use at bedtime.

https://pubmed.ncbi.nlm.nih.gov/35400615/

PERSONAL RADIOFREQUENCY ELECTROMAGNETIC FIELD EXPOSURE OF ADOLESCENTS IN THE GREATER LONDON AREA AND THE ASSOCIATION WITH RESTRICTIONS ON PERMITTED USE OF MOBILE COMMUNICATION TECHNOLOGIES AT SCHOOL AND AT HOME

Claudia Schmutz, Alexandra Bürgler, Narain Ashta, Jana Soenksen, Yasmin Bou Karim, Chen Shen, Rachel B. Smith, Rosemary H. Jenkins, Michael O. Mireku, Julian Mutz, Mikaël J.A. Maes, Rosi Hirst, Irene Chang, Charlotte Fleming, Aamirah Mussa, Daphna Kesary, Darren Addison, Myron Maslanyj, Mireille B. Toledano, Martin Röösli, Marloes Eeftens. Environmental Research. 2022. 113252. doi:10.1016/j.envres.2022.113252.

Abstract

Personal measurements of radiofrequency electromagnetic fields (RF-EMF) have been used in several studies to characterise personal exposure in daily life, but such data are limitedly available for adolescents, and not yet for the United Kingdom (UK). In this study, we aimed to

characterise personal exposure to RF-EMF in adolescents and to study the association between exposure and rules applied at school and at home to restrict wireless communication use, likely implemented to reduce other effects of mobile technology (e.g. distraction). We measured exposure to RF-EMF for 16 common frequency bands (87.5 MHz–3.5 GHz), using portable measurement devices (ExpoM-RF), in a subsample of adolescents participating in the cohort Study of Cognition, Adolescents and Mobile Phones (SCAMP) from Greater London (UK) (n = 188). School and home rules were assessed by questionnaire and concerned the school's availability of WiFi and mobile phone policy, and parental restrictions on permitted mobile phone use. Adolescents recorded their activities in real time using a diary app on a study smartphone, while characterizing their personal RF-EMF exposure in daily life, during different activities and times of the day. Data analysis was done for 148 adolescents from 29 schools who recorded RF- EMF data for a median duration of 47 h. The majority (74%) of adolescents spent part of their time at school during the measurement period. Median total RF-EMF exposure was 40 µW/m2 at home, 94 µW/m2 at school, and 100 µW/m2 overall. In general, restrictions at school or at home made little difference for adolescents' measured exposure to RF-EMF, except for uplink exposure from mobile phones while at school, which was found to be significantly lower for adolescents attending schools not permitting phone use at all, compared to adolescents attending schools allowing mobile phone use during breaks. This difference was not statistically significant for total personal exposure. Total exposure to RF-EMF in adolescents living in Greater London tended to be higher compared to exposure levels reported in other European countries. This study suggests that school policies and parental restrictions are not associated with a lower RF-EMF exposure in adolescents.
https://www.sciencedirect.com/science/article/pii/S0013935122005795

SAR AND THERMAL DISTRIBUTION OF PREGNANT WOMAN AND CHILD INSIDE ELEVATOR CABIN

Loanna Karatsi, Sofia Bakogianni, Stavros Koulouridis. (2022). SAR and thermal distribution of pregnant woman and child inside elevator cabin. International Journal of Microwave and Wireless Technologies, 1-14. doi:10.1017/S1759078722000253.

Abstract

A detailed dosimetry study of electromagnetic absorption and temperature rise under real scenarios is delivered when a mobile phone is used inside an elevator cabin. Numerically accurate human models of a 7th month pregnant woman and a 5-year-old female child are utilized as the exposed subjects. The female child acts as the phone user. The mobile phone is modeled in three talk positions (parallel, tilt, and cheek) operating at 1000 MHz and 1800 MHz. From the obtained numerical results for the specific absorption rate (SAR) and temperature rise induced by the mobile radiofrequency (RF) radiation, it is found that the child's RF exposure is significantly affected by the phone position and less affected by the relevant position of the human models. The exact opposite case applies for the pregnant woman model and its fetus. Almost all numerical investigations are carried out inside a metallic elevator cabin.

Open access paper: https://bit.ly/SARelevator

EXPOSURE TO RF ELECTROMAGNETIC FIELDS IN THE CONNECTED VEHICLE: SURVEY OF EXISTING AND FORTHCOMING SCENARIOS

G. Tognola, M. Bonato, M. Benini, S. Aerts, S. Gallucci, E. Chiaramello, S. Fiocchi, M. Parazzini, B. Masini, W. Joseph, J. Wiart, P. Ravazzani. Exposure to RF Electromagnetic Fields in the Connected Vehicle: Survey of Existing and Forthcoming Scenarios.IEEE Access, doi: 10.1109/ACCESS.2022.3170035.

Abstract

Future vehicles will be increasingly connected to enable new applications and improve safety, traffic efficiency and comfort, through the use of several wireless access technologies, ranging from vehicle-to-everything (V2X) connectivity to automotive radar sensing and Internet of Things (IoT) technologies for intra-car wireless sensor networks. These technologies span the radiofrequency (RF) range, from a few hundred MHz as in intra-car network of sensors to hundreds of GHz as in automotive radars used for in-vehicle occupant detection and advanced driver assistance systems. Vehicle occupants and road users in the vicinity of the connected vehicle are thus daily immersed in a multi-source and multi-band electromagnetic field (EMF) generated by such technologies. This paper is the first comprehensive and specific survey about EMF exposure generated by the whole ensemble of connectivity technologies in cars. For each technology we describe the main characteristics, relevant standards, the application domain, and the typical deployment in modern cars. We then extensively characterize the EMF exposure scenarios resulting from such technologies by resuming and comparing the outcomes from past studies on the exposure in the car. Results from past studies suggested that in no case EMF exposure was above the safe limits for the general population. Finally, open challenges for a more realistic characterization of the EMF exposure scenario in the connected car are discussed.

Open access paper:

https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9762806&isnumber=6514899

DESIGN AND MANUFACTURE OF ELECTROMAGNETIC ABSORBER COMPOSED OF BORIC ACID-INCORPORATED WASTEPAPER COMPOSITES

ALİ İHSAN KAYA, AHMET ÇİFCİ, FİLİZ KIRDIOĞULLARI, MESUD KAHRİMAN, OSMAN ÇEREZCI. Design and
manufacture of electromagnetic absorber composed of boric acid-incorporated wastepaper composites. Turk J Elec Eng & Comp Sci. 2022. 30: 839 – 854. doi:10.3906/elk-2106-21.

Abstract

With the effect of technological advances, the use of electrical and electronic devices has increased dramatically in recent years. Wireless technologies and related applications are mostly preferred for the communication of these devices with each other. Thus, people are easily exposed to electromagnetic waves in daily life. The extensive global use of these devices raises the question of their possible biological effects on human health.

Also, electromagnetic waves influence the functioning of a nearby device. In this study, an electromagnetic absorber based on boric acid (5, 10, 20, and 30 wt%) added wastepaper was developed. Copper (Cu) and aluminum (Al) were also used as mineral additives for comparison. Three different kinds of wastepaper namely, office paper, newsprint, and

cardboard paper were selected for the experimental study. The effect of varying boric acid contents on the electromagnetic absorption of the boards manufactured was evaluated and compared to Cu (30 wt%) and Al (30 wt%) added boards. The results show that newsprint has better absorption effectiveness than office and cardboard paper and absorption up to 40 dB was achieved. The absorption effectiveness of Al, Cu, and boric acid added boards was achieved at approximately 40, 30, and 20 dB, respectively. As a result, the electromagnetic absorption effectiveness of boric acid added the board is acceptable levels. Also, apart from the use of boric acid as a powder, it has been determined that the application of the surface as a layer is effective in absorption.

Open access paper: https://journals.tubitak.gov.tr/elektrik/issues/elk-22-30-3/elk-30-3-23-2106-21.pdf

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CELL RESPONSIVENESS TO PHYSICAL ENERGIES: PAVING THE WAY TO DECIPHER A MORPHOGENETIC CODE

Ricardo Tassinari, Claudia Cavallini, Elena Olivi, Federica Facchin, Valentina Taglioli, Chiara Zannini, Martina Marcuzzi, Carlo Ventura. 2022. Cell Responsiveness to Physical Energies: Paving the Way to Decipher a Morphogenetic Code. International Journal of Molecular Sciences 23(6):3157. doi: 10.3390/ijms23063157.

Abstract

We discuss emerging views on the complexity of signals controlling the onset of biological shapes and functions, from the nanoarchitectonics arising from supramolecular interactions, to the cellular/multicellular tissue level, and up to the unfolding of complex anatomy. We highlight the fundamental role of physical forces in cellular decisions, stressing the intriguing similarities in early morphogenesis, tissue regeneration, and oncogenic drift. Compelling evidence is presented, showing that biological patterns are strongly embedded in the vibrational nature of the physical energies that permeate the entire universe. We describe biological dynamics as informational processes at which physics and chemistry converge, with nanomechanical motions, and electromagnetic waves, including light, forming an ensemble of vibrations, acting as a sort of control software for molecular patterning. Biomolecular recognition is approached within the establishment of coherent synchronizations among signaling players, whose physical nature can be equated to oscillators tending to the coherent synchronization of their vibrational modes. Cytoskeletal elements are now emerging as senders and receivers of physical signals, “shaping” biological identity from the cellular to the tissue/organ levels. We finally discuss the perspective of exploiting the diffusive features of physical energies to afford in situ stem/somatic cell reprogramming, and tissue regeneration, without stem cell transplantation.

Open access paper: https://www.mdpi.com/1422-0067/23/6/3157/htm

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AN INTERNATIONAL COLLABORATIVE ANIMAL STUDY OF THE CARCINOGENICITY OF MOBILE PHONE RADIOFREQUENCY RADIATION: CONSIDERATIONS FOR PREPARATION OF A GLOBAL PROJECT

Ahn YH, Imaida K, Kim YB, Han KH, Pack JK, Kim N, Jeon SB, Lee AK, Choi HD, Wang J, Kawabe M, Kim HS. Bioelectromagnetics. 2022 Apr 27. doi: 10.1002/bem.22407

Abstract

Radiofrequency radiation (RFR) was classified as a "possible" human carcinogen in 2011, which caused great public concern. A carcinogenicity study by the National Toxicology Program (NTP) found Code Division Multiple Access-and Global System for Mobile Communications-modulated mobile phone RFR to be carcinogenic to the brain and heart of male rats. As part of an investigation of mobile phone carcinogenesis, and to verify the NTP study results, a 5-year collaborative animal project was started in Korea and Japan in 2019. An international animal study of this type has two prerequisites: use of the same study protocol and the same RF-exposure system. This article discusses our experience in the design of this global study on radiofrequency electromagnetic fields (RF-EMFs).

https://pubmed.ncbi.nlm.nih.gov/35476263/

TRANSCRIPTOMIC AND LONG-TERM BEHAVIORAL DEFICITS ASSOCIATED WITH DEVELOPMENTAL 3.5 GHZ RADIOFREQUENCY RADIATION EXPOSURES IN ZEBRAFISH

Subham Dasgupta, Connor Leong, Michael T Simonich, Lisa Truong, Huaping Liu, Robyn L Tanguay. Transcriptomic and Long-Term Behavioral Deficits Associated with Developmental 3.5 GHz Radiofrequency Radiation Exposures in Zebrafish. Environ Sci Technol Lett. 2022 Apr 12;9(4):327-332. doi: 10.1021/acs.estlett.2c00037.

Abstract

The rapid deployment of the fifth-generation (5G) spectrum by the telecommunication industry is intended to promote better connectivity and data integration among various industries. However, concerns among the public about the safety and health effects of radiofrequency radiations (RFRs) emitted from the newer- generation cell phone frequencies remain, partly due to the lack of robust scientific data. Previously, we used developmental zebrafish to model the bioactivity of 3.5 GHz RFR, a frequency used by 5G-enabled cell phones, in a novel RFR exposure chamber. With RFR exposures from 6 h post-fertilization (hpf) to 48 hpf, we observed that, despite no teratogenic effects, embryos showed subtle hypoactivity in a startle response behavior assay, suggesting abnormal sensorimotor behavior. This study builds upon the previous one by investigating the transcriptomic basis of RFR-associated behavior effects and their persistence into adulthood. Using mRNA sequencing, we found a modest transcriptomic disruption at 48 hpf, with 28 differentially expressed genes.

KEGG pathway analysis showed that biochemical pathways related to metabolism were significantly perturbed. Embryos were grown to adulthood, and then a battery of behavioral assays suggested subtle but significant abnormal responses in RFR-exposed fish across the different assays evaluated that suggest potential long-term behavioral effects. Overall, our study suggests the impacts of RFRs on the developing brain, behavior, and the metabolome should be further explored.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9009179/

BIOLOGICAL EFFECTS OF NON-IONIZING ELECTROMAGNETIC FIELDS AT 27 GHZ ON SPERM QUALITY OF MYTILUS GALLOPROVINCIALIS

Roberta Pecoraro, Santi C. Pavone, Elena M. Scalisi, Carmen Sica, Sara Ignoto, Martina Contino, Antonio Salvaggio, Dimitra Marmara, Gino Sorbello, Loreto Di Donato, Maria V. Brundo. 2022. Biological Effects of Non- Ionizing Electromagnetic Fields at 27 GHz on Sperm Quality of Mytilus galloprovincialis. Journal of Marine Science and Engineering. 10(4):521. doi: 10.3390/jmse10040521

Abstract

Recently, an increasing use of wireless internet technologies has been demonstrated. The devices which use these technologies emit in new spectral regions an electromagnetic radiation (EMF) which could interact with the male reproductive system. The aim of this study was to investigate in vitro the effect of electromagnetic fields at 27 GHz on sperm quality in Mytilus galloprovincialis. Sperm samples were collected from sexually mature males of M. galloprovincialis and placed in seawater. Once we evaluated the number and quality of spermatozoa, sperm cells were exposed to electromagnetic fields radiated by a pyramidal horn antenna. The effect of exposure was evaluated after 10, 20, 30, 40 and 60 min by a light microscope and using an Eosin test. Ten replications were performed for each time series, and statistical analysis was carried out by t-test. Sperm motility decreased after 10 min of exposure, and after 30 min most of the spermatozoa were immobile and not vital. This study provides useful data on the potential ecological impact of the high-band 5G on animal fertility, the effect of which is currently under investigation.

Conclusions

This study indicates that electromagnetic fields at 27 GHz can affect the sperm quality in marine mussel Mytilus galloprovincialis. The significative decrease observed in sperm motility after only 10 min of exposure represents a crucial factor to be considered because it can threaten the reproductivity of the species. This study provides useful data on the potential impact of high frequency EMFs on aquatic animals and cells, which is currently poorly investigated. Future research could benefit from specific investigations into the impact of 5G to better monitor the effects on animal organisms and to fill the gap currently known about the interactions with artificial sources of electromagnetic fields.

Open access paper: https://www.mdpi.com/2077-1312/10/4/521

IN VIVO FUNCTIONAL ULTRASOUND (FUS) REAL-TIME IMAGING AND DOSIMETRY OF MICE BRAIN UNDER RADIOFREQUENCY EXPOSURE

Rosa Orlacchio, Yann Percherancier, Florence Poulletier De Gannes, Annabelle Hurtier, Isabelle Lagroye, Philippe Leveque, Delia Arnaud-Cormos. In Vivo Functional Ultrasound (fUS) Real-Time Imaging and Dosimetry of Mice Brain Under Radiofrequency Exposure. Bioelectromagnetics. 2022 Apr 29. doi: 10.1002/bem.22403.

Abstract

This study aims to analyze in real-time the potential modifications induced by low-level continuous-wave and Global System for Mobile Communications radiofrequency (RF) exposure at 1.8 GHz on brain activation in anesthetized mice. A specific in vivo experimental setup consisting of a dipole antenna for the local exposure of the brain was fully characterized. A unique neuroimaging technique based on a functional ultrasound (fUS)

probe was used to observe the areas of mice brain activation simultaneously to the RF exposure with unprecedented spatial and temporal resolution (~100 µm, 1 ms) following manual whisker stimulation using a brush. Numerical and experimental dosimetry was carried out to characterize the exposure and to guarantee the validity of the biological results. Our results show that the fUS probe can be efficiently used during in vivo exposure without interference with the dipole. In addition, we conclude that exposure to brain-averaged specific absorption rate levels of 2 and 6 W/kg does not introduce significant changes in the time course of the evoked fUS response in the left barrel field cortex. The proposed technique represents a valuable instrument for providing new insights into the possible effects induced on brain activation under RF exposure. For the first time, brain activity under mobile phone exposure was evaluated in vivo with fUS imaging, paving the way for more realistic exposure configurations, i.e. awake mice and new signals such as the 5 G networks.
https://pubmed.ncbi.nlm.nih.gov/35485721/

NEUROLOGICAL EFFECTS OF STATIC AND EXTREMELY-LOW FREQUENCY ELECTROMAGNETIC FIELDS (REVIEW)

Henry Lai. Neurological effects of static and extremely-low frequency electromagnetic fields. Electromagn Biol Med. 2022 Apr 15:1-21. doi: 10.1080/15368378.2022.2064489.

Abstract

This is a review of studies on the neurological effects of static/extremely-low frequency (ELF) electromagnetic fields (EMF). The review is mainly on research carried out in the last two decades. There are studies that showed effects on various neurotransmitters, including NMDA, serotonin, dopamine, endogenous opioids, etc. Each of these transmitters plays different critical roles on behavior and brain functions. Studies on behavioral effects of static/ELF EMF bear out these connections. Static/ELF EMF-induced behavioral and pathological effects, such as locomotor activity, memory and learning deficits, and neurological diseases (Alzheimer's, Parkinson's disease, Huntinton's diseases and atropical lateral scleroses, etc.) are discussed. Static/ELF EMF exposure has also been shown to have beneficial effects on functional deficits and progression of some neurological diseases. These fields provide a non-invasive treatment or treatment-adjuvant for these detrimental neurological conditions.

Results suggest that free radicals, both reactive oxygen species and reactive nitric species could be involved. Depending on the conditions of exposure, either harmful or beneficial effects could result. It is important to carry out further investigation to identify these conditions. However, caution should be taken to extrapolate the experimental data to human exposure, since higher field intensities than environmental levels were used in most laboratory research.
https://pubmed.ncbi.nlm.nih.gov/35426330/

EFFECTS OF MODERATE TO HIGH STATIC MAGNETIC FIELDS ON REPRODUCTION (REVIEW)

Chao Song, Biao Yu, Junjun Wang, Yiming Zhu, Xin Zhang. Effects of Moderate to High Static Magnetic Fields on Reproduction. Bioelectromagnetics. 2022 Apr 29. doi: 10.1002/bem.22404.

Abstract

With the wide application of magnetic resonance imaging in hospitals and permanent magnets in household items, people have increased exposure to various types of static magnetic fields (SMFs) with moderate and high intensities, which has caused a considerable amount of public concern. Studies have shown that some aspects of gametogenesis and early embryonic development can be significantly affected by SMFs, while others have shown no effects. This review summarizes the experimental results of moderate to high-intensity SMFs (1 mT-16.7 T) on the reproductive development of different model animals, and we find that the effects of SMFs are variable depending on experimental conditions. In general, the effects of inhomogeneous SMFs seem to be more significant compared to that of homogeneous SMFs, which is likely due to magnetic forces generated by the magnetic field gradient. Moreover, some electromagnetic fields may have induced bioeffects because of nonnegligible gradient and heat effect, which are much reduced in superconducting magnets. We hope this review can provide a starting point for more in-depth analysis of various SMFs on reproduction, which is indispensable for evaluating the safety and potential applications of SMFs on living organisms in the future.

https://pubmed.ncbi.nlm.nih.gov/35485707/

LF-EMF COMPOUND BLOCK TYPE SIGNAL ACTIVATES HUMAN NEUTROPHILIC GRANULOCYTES IN VIVO

Jan J M Cuppen, Cristian Gradinaru, Bregje E Raap-van Sleuwen, Anna C E de Wit, Ton A A J van der Vegt, Huub F J Savelkoul. LF-EMF Compound Block Type Signal Activates Human Neutrophilic Granulocytes In Vivo. Bioelectromagnetics. 2022 Apr 28. doi: 10.1002/bem.22406.

Abstract

This research aims to demonstrate in a randomized, placebo-controlled crossover design study that a nominal 5 µT low-frequency electromagnetic field (LF-EMF) signal for 30 min activates neutrophils in vivo in humans. Granularity of neutrophils was measured in blood samples of healthy human volunteers (n = 32) taken before and after exposure for both the exposure and control sessions. A significant decrease in the granularity, indicative of neutrophil activation, was observed both in the exposure measurements and the exposure minus control measurements. Earlier EMF publications show immune function increase in isolated cells and more effective immune responses in animals with infections. This result, therefore, supports the thesis that the exposure can activate the innate immune system in humans, speed up the innate immune response, and may have potential beneficial effects in infectious disease.

https://pubmed.ncbi.nlm.nih.gov/35481557/

EXPOSURE TO MAGNETIC FIELDS CHANGES THE BEHAVIORAL PATTERN IN HONEYBEES UNDER LABORATORY CONDITIONS

Paweł Migdał, Ewelina Berbeć, Paweł Bieńkowski, Mateusz Plotnik, Agnieszka Murawska, Krzysztof Latarowski. Exposure to Magnetic Fields Changes the Behavioral Pattern in Honeybees (Apis mellifera L.) under Laboratory Conditions. Animals (Basel). 2022 Mar 29;12(7):855. doi: 10.3390/ani12070855.

Abstract

Earth's magnetic field (MF) plays an important role for many species, including the honeybee, in navigation. Nowadays, much larger alternating fields are emitted by miscellaneous electric infrastructure components, such as transformers and power lines, and the environment is therefore polluted by an anthropogenic electromagnetic field, though little is known regarding its impact on living organisms. The behavior of animals is the first and easiest way to establish the impact of stress. It shows if the animal can detect the exposure and react to it. To investigate this, one-day-old bees were exposed to a 50 Hz magnetic field of induction at 1 mT and 1.7 mT for 10 min, 1 h, and 3 h under laboratory conditions. All groups exposed to the magnetic field showed differences in behavioral patterns. What is more, they presented a behavior absent in the control: loss of balance. There were differences, both in the ratio of behaviors and in the number of bouts-exposed bees more often changed behavior. Occurrence of differences is an indication of the reaction of the honeybee organism to the magnetic field. Loss of balance is a disturbing symptom, and behavior changes indicate a disturbance of the honeybee by the electromagnetic field.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8996969/

ELECTROMAGNETIC FIELD EXPOSURE ALTERS IN VITRO ESTROGEN BIOSYNTHESIS AND ITS RELEASE BY THE PORCINE ENDOMETRIUM IN THE PERI-IMPLANTATION PERIOD

Wiktoria Kozlowska, Ewa Monika Drzewiecka, Agata Zmijewska, Anita Franczak. Electromagnetic field exposure alters in vitro estrogen biosynthesis and its release by the porcine endometrium in the peri-implantation period. Reprod Biol. 2022 Apr 26;22(2):100642. doi: 10.1016/j.repbio.2022.100642.

Abstract

The electromagnetic field (EMF) is an environmental risk factor that may impair living organisms. This study aims to determine the functional effects of EMF exposure at 50 and 120 Hz for 2 or 4 h on estrogen synthesis and release in the endometrium. Endometrial slices were isolated from pigs (n = 5) during the peri-implantation period. To check whether progesterone (P4) exerts any protective effects against EMF, selected EMF-treated slices were also treated with P4. CYP19A3 mRNA transcript abundance was higher in slices exposed to EMF (50 Hz, 4 h) and treated with P4. HSD17B4 mRNA transcript abundance was higher in slices exposed to EMF (50 and 120 Hz, 2 h) without P4 treatment. Both EMF (50 Hz, 2 h) and EMF (50 and 120 Hz, 4 h) increased HSD17B4 mRNA transcript abundance in the presence of P4; EMF (120 Hz, 2 h, and 50 Hz, 4 h) decreased cytochrome P- 450arom protein abundance in tissue slices not treated with P4. Under exposure to EMF at 120 Hz (2 h), the abundance of hydroxysteroid 17β dehydrogenase decreased in P4-treated slices and increased in slices not treated with P4 (4 h). Progesterone treatment decreased the release of estradiol-17β (E2) in endometrial slices exposed to EMF at 50 Hz (2 h), whereas in slices not treated with P4, EMF (120 Hz, 2 h) increased estrone (E1) release compared to control (without EMF). The EMF could disrupt the

synthesis and release of E1 and E2 by the porcine endometrium during the peri-implantation period.
Open access paper:
https://www.sciencedirect.com/science/article/pii/S1642431X22000419?via%3Dihub

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SEARCHING FOR UNITY IN DIVERSITY OF ANIMAL MAGNETORECEPTION: FROM BIOLOGY TO QUANTUM MECHANICS AND BACK

Can Xie. Searching for unity in diversity of animal magnetoreception: From biology to quantum mechanics and back. Innovation (N Y). 2022 Mar 11;3(3):100229. doi: 10.1016/j.xinn.2022.100229.

Abstract

How animals sense the geomagnetic field remains a mystery today. A remarkable diversity has been revealed in animal magnetoreception and several sophisticated models have been put forward in the past few decades, but none have been commonly accepted yet. Cryptochrome (Cry) has been proposed in both the radical pair model and the MagR/Cry-based biocompass model. How exactly it participates in magnetic sensing is an ongoing discussion. Here we wish to suggest an intermolecular electron transport (ET) pathway conserved in evolution in the MagR/Cry complex, in which electrons travel stepwise along a flavin-tryptophan chain as described in the classic radical pair model, and further extends to iron-sulfur clusters in MagR via a series of stepping-stone amino acids as an ET bridge. The hypothesis we presented here may provide a solution to unite different models, and a feasible explanation for the intrinsic magnetic features of MagR, as well as a mechanism for signaling in animal magnetoreception, which are of considerable interest in both biology and physics.
Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8966150/

INDIVIDUAL VARIABILITY IN SPACE USE NEAR POWER LINES BY A LONG-LIVED TERRITORIAL RAPTOR

Marques AT, Palma L, Lourenço R, Cangarato R, Leitão A, Mascarenhas M, Tavares JT, Tomé R, Moreira F, Beja P. Individual variability in space use near power lines by a long-lived territorial raptor. Ecol Evol. 2022 Apr 7;12(4):e8811. doi: 10.1002/ece3.8811.

Abstract

Evaluating species responses to anthropogenic infrastructures and other habitat changes is often used to assess environmental impacts and to guide conservation actions. However, such studies are generally carried out at the population level, disregarding inter-individual variability. Here, we investigate population- and individual-level responses toward power lines of a territorial raptor, the Bonelli's eagle Aquila fasciata. We used GPS-PTT tracking data of 17 adult eagles to model space use as a function of distance to transmission and distribution lines, while accounting for other habitat features known to affect this species. At population level, eagles increased the intensity of space use in the proximity of power lines (up to 1,000 m), suggesting an attraction effect. At individual level, some eagles shared the general population attraction pattern, while others showed reduced intensity of space use in the proximity of power lines. These differential responses were unrelated to the sex of individuals, but were affected by the characteristics of the power grid, with a tendency for apparent attraction to be associated with individuals occupying home ranges with a denser network of transmission lines and transmission pylons. However, the study could not rule out

the operation of other potentially influential factors, such as individual idiosyncrasies, the spatial distribution of prey availability, and the availability of natural perches and nesting sites. Overall, these results suggest that power lines may drive different behaviors and have differential impacts across individuals, with those attracted to the proximity of power lines potentially facing increased risk of mortality through electrocution and collision, and those avoiding power lines being potentially subject to exclusion effects. More generally, our results reinforce the need to understand individual variability when assessing and mitigating impacts of anthropogenic infrastructures.
Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8987490/

THE MORAL HAZARD OF LAX FCC LAND USE OVERSIGHT FOR ADVANCED NETWORK INFRASTRUCTURE

Benjamin W. Cramer. The moral hazard of lax FCC land use oversight for advanced network infrastructure. Telecommunications Policy. 46(1). 2022. doi: 10.1016/j.telpol.2021.102232.

Abstract

This article discusses issues that arise when service providers place network equipment on publicly owned lands in the United States. Based on land use policy at the Federal Communications Commission, this paper theorizes that the use of public lands for 5G network development will create a moral hazard, as service providers may be tempted to take risks in the way they use public lands. Per economic theory the firm could behave recklessly when knowing that the costs will be borne by someone else – in this case local citizens. This is an example of the moral hazard problem in economics.

Conclusion and recommendations

This article has argued that FCC land usage regulations, covered by Section 253 in the Telecommunications Act of 1996, remove local governments as decisionmakers in land management. The result is that telecommunications firms have little incentive to use publicly owned land efficiently or equitably, and the FCC has little incentive to make sure that they do. Without these incentives, a moral hazard forms in which local citizens must accept the costs (financial or otherwise) of poor land use practices for telecom infrastructure. The FCC's more recent enhancement of such regulations in order to speed up the 5G rollout, regardless of the interests of local governments and citizens, will create additional moral hazards that in turn will encourage firms to abuse the land that they have been permitted to build upon.

The FCC's plans for the 5G rollout, as described for the public at the Commission website, include many promises to “speed up the process” of deployment and “make it easier for companies to invest” in network equipment (FCC, 2021(a)), which could indeed encourage cutting corners and making land use decisions without considering the longer-term consequences. There have in fact been a few successful local challenges against land use decisions made by telecom providers for 5G and other recent infrastructure. Douglas County, Colorado denied a visually unattractive tower proposed by T-Mobile and prevailed in court (Reid, 2020). The city of San Jose, California has convinced AT&T and Verizon to adapt their local 5G infrastructure plans with San Jose's “smart city” initiative, with a focus on environmental protection and sustainability (Moss, 2018).

On the other hand, the telecommunications industry also has a history of ignoring local restrictions or regulations on land use. The present author does not wish to imply that this will happen often, and in fact it may be quite rare. However, such things have happened before in the telecommunications sector and other networked industries. For example, in 2001 MCI Worldcom started building network infrastructure on a strategic plot of public land in Indiana; due to vague local permitting processes the company was able to ignore the wishes of the local community and did not bother to get permission to build. In Peeler v. MCI Worldcom, an Indiana court charged the company with willful trespass and ordered it to remove all the equipment it had placed at the location, which cost the company millions of dollars per month until the matter was resolved.

During that same period, researchers uncovered internal documents at AT&T in which the company admitted to using various public land parcels without adequate permission. The company rationalized its actions by claiming pressure to build network coverage that was demanded by the marketplace, but admitted that its legal position was “precarious” and “far from sound” (Ackerson, 2003, pp. 184–185). This behavior seems to have been inherited from telecom's ancestor in the realm of networked industries – railroads – which in the late 1800s often built tracks across public lands without permission (because overseeing governments were often very far away or unable to enforce regulations), and used the same argument about market pressure to build first and ask questions later (Ackerson, 2003, pp. 180–181).

Those unauthorized uses of land caused various environmental or economic harms with various levels of severity, but they were all enabled by the type of moral hazard covered in this article. While telecommunications firms have other incentives to behave, especially public relations benefits, there is little guarantee that land-use horror stories will never happen during the 5G rollout, as shown by older history and current regulatory practices.

The economics literature has shown that moral hazards are more common than usual among complex corporations that are pressured by shareholders to take risks for profit purposes, and in industries dominated by natural monopolies or oligopolies (Laffont, 1995, pp. 319–320). The telecommunications industry exhibits both of these characteristics. Large corporations are also expected to make large profits in ways that conflict with risk reduction efforts in non-economic areas like environmental compliance, while the structure of such corporations reduces the ability of managers to oversee the environmental activities of workers at the level needed to prevent damage before it occurs (Gabel & Sinclair-Desgagné, 1993, pp. 229–233).

These are traditional reasons for regulatory oversight of corporations and industries, and such oversight has been lacking for the use of publicly owned lands by telecom firms. Well-designed public policy is necessary in any advanced society, especially for practices that create moral hazards and principal-agent problems (Bergman & Lane, 1990, p. 339). Oversight of corporate actors (“agents”) will discourage them from hiding information, which in turn gives them an advantage over the contractual relationship; regulators (“principals”) could level the informational playing field with incentives and rewards for behaving equitably (Hiriart & Martimort, 2004, pp. 4– 5). This article also positions the FCC as a somewhat aloof player in the principal-agent problem of telecom land usage, and this increases the distance and misunderstandings between the ultimate regulator (the FCC) and the ultimate sufferers of

land use inequities (citizens), with the potential intermediary (local government) largely cut out of the process. This type of fractured arrangement is known to induce additional moral hazards as well (Bergman & Lane, 1990, p. 345).

This problem can be addressed with stronger institutional oversight (Braun & Guston, 2003, p. 303). Such oversight has been found to be particularly effective in encouraging firms to manage their environmental impact by reducing their temptations to engage in risky behavior (Gabel & Sinclair-Desgagné, 1993, pp. 238–239). This article recommends that FCC regulations regarding usage of public lands for advanced network construction should acknowledge the needs of affected landowners and local communities. This can be accomplished with a replacement of Section 253 of the Telecommunications Act, or at least a softer interpretation of it. This may require Congressional action.

By requiring the needs of the network and of telecom firms to be considered first in any local land use regulation, the concerns of local governments – who are much more knowledgeable about local conditions and the interests of citizens – are frozen out of the process almost a priori. This regulatory pattern incentivizes firms to never consider any interests other than their own when they use publicly owned lands. While few well- managed firms will succumb to the temptation, history shows that some might, and the effects must be suffered by everyone else. A possible solution is to encourage more equitable viewpoints on the American telecommunications regulations that enable the discrepancies of knowledge and power embodied in the principal-agent relationship at hand, which in turn will reduce the possible moral hazard of risky land use by one party who knows that someone else will have to deal with the consequences.

https://www.sciencedirect.com/science/article/pii/S0308596121001361

Conference paper (open access): https://bit.ly/FCCmoralhazard

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CELLULAR TELEPHONE USE AND THE RISK OF BRAIN TUMORS: UPDATE OF THE UK MILLION WOMEN STUDY

Joachim Schüz, Kirstin Pirie, Gillian K Reeves, Sarah Floud, Valerie Beral, for the Million Women Study Collaborators. Cellular Telephone Use and the Risk of Brain Tumors: Update of the UK Million Women Study. JNCI: Journal of the National Cancer Institute, 2022, djac042, doi: 10.1093/jnci/djac042.

Abstract

The ongoing debate of whether use of cellular telephones increases the risk of developing a brain tumor was recently fueled by the launch of the fifth generation of wireless technologies. Here, we update follow-up of a large-scale prospective study on the association between cellular telephone use and brain tumors.During 1996- 2001, 1.3 million women born in 1935-1950 were recruited into the study. Questions on cellular telephone use were first asked in median year 2001 and again in median year 2011. All study participants were followed via record linkage to National Health Services databases on deaths and cancer registrations (including nonmalignant brain tumors).During 14 years follow-up of 776 156 women who completed the 2001 questionnaire, a total of 3268 incident brain tumors were registered. Adjusted relative risks for ever vs never cellular telephone use were 0.97 (95% confidence

interval = 0.90 to 1.04) for all brain tumors, 0.89 (95% confidence interval = 0.80 to 0.99) for glioma, and not statistically significantly different to 1.0 for meningioma, pituitary tumors, and acoustic neuroma. Compared with never-users, no statistically significant associations were found, overall or by tumor subtype, for daily cellular telephone use or for having used cellular telephones for at least 10 years. Taking use in 2011 as baseline, there were no statistically significant associations with talking for at least 20 minutes per week or with at least 10 years use. For gliomas occurring in the temporal and parietal lobes, the parts of the brain most likely to be exposed to radiofrequency electromagnetic fields from cellular telephones, relative risks were slightly below 1.0.Our findings support the accumulating evidence that cellular telephone use under usual conditions does not increase brain tumor incidence.
Open access paper: https://doi.org/10.1093/jnci/djac042
For a critique of this paper see: https://www.saferemr.com/2022/03/the-uk-million-women-study-of-cell.html

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THE DYNAMICS OF THE RADIATED FIELD NEAR A MOBILE PHONE CONNECTED TO A 4G OR 5G NETWORK

D. B. Deaconescu, A. M. Buda, D. Vatamanu, S. Miclaus. The Dynamics of the Radiated Field Near a Mobile Phone Connected to a 4G or 5G Network. Eng. Technol. Appl. Sci. Res. 12(1):8101–8106, Feb. 2022.

Abstract

Characterizing the time variations of signals emitted by mobile terminals provides complementary information to health authorities, especially with the increase of frequency and energy of radiation towards millimeter waves. This experimental work aimed to quantify and classify the time variability of the electric field level measured at 10cm from a mobile phone connected sequentially to a 4th and 5th generation mobile network.

Statistic analysis was performed on data from real-time spectrum analyzers, while self-similarity was computed by first recurrence plots of the radiated emissions, corresponding to five different types of mobile applications. Moreover, specificities to the communication standard and the type of application were identified.

Conclusions

This study aimed to identify the differences in the time variability of signals emitted by a mobile phone when sequentially connected to a 4G-LTE or 5G-NR network. The main reason behind this study was the need of describing not only the dose of radiation absorbed by a human body while using a phone but also the average or the momentary dose rate. While the present safety exposure standards do not yet expressly require such knowledge, increasing the frequency towards tens of GHz in 5G networks means an increase in the energy of the radiation so it might need a time-dependent description similar to the ionizing radiation. Moreover, the averaging time used to describe the biological impact of the field is also very important to accurately describe the safety of people exposed to very short and quasi-stochastic pulses [31].

By experimentally determining the E-field strength variation during the 25s usage of 5 different mobile communication activities in either 4G or 5G networks, which allowed TDD

technique and respectively had 20 and 40MHz bandwidths for the transmission, streams of 250 field values were gathered and treated as time- series. The boxplot representations of these data allowed obtaining descriptive statistic distributions, while the Poincare plots showed self similarity by first recurrence means. The results showed that: a) more intensive dynamics are encountered generally in 5G UL signal than in 4G, b) the time variability is dependent not only on the communication standard but also on the type of mobile application used, c) short-term variability is lower than long term when using a 4G application, as compared to 5G where the short-term variability of field level is higher than the long term, d) the lowest ratio between short- and long-time variabilities was encountered for file upload in 4G, while the highest ratio was encountered for file download in 5G, and e) the largest total variabilities in 4G were associated to upload and video call, while in 5G they were noted during voice call and file download. These results provide important knowledge that completes the picture of amplitude-time variation of human exposure to near-the-body used mobile devices.

Open access paper: https://etasr.com/index.php/ETASR/article/view/4670/2663

LOW INTENSITY ELECTROMAGNETIC FIELDS ACT VIA VOLTAGE-GATED CALCIUM CHANNEL (VGCC) ACTIVATION TO CAUSE VERY EARLY ONSET ALZHEIMER'S DISEASE: 18 DISTINCT TYPES OF EVIDENCE

Martin L. Pall. Low Intensity Electromagnetic Fields Act via Voltage-Gated Calcium Channel (VGCC) Activation to Cause Very Early Onset Alzheimer's Disease: 18 Distinct Types of Evidence. Curr Alzheimer Res. 2022 Feb 2. doi: 10.2174/1567205019666220202114510.

Abstract

Electronically generated electromagnetic fields (EMFs) including those used in wireless communication such as cell phones, Wi-Fi and smart meters, are coherent, producing very high electric and magnetic forces which act on the voltage sensor of voltage-gated calcium channels to produce increases in intracellular calcium [Ca2+]i. The calcium hypothesis of Alzheimer's disease (AD) has shown that each of the important AD-specific and nonspecific causal elements are produced by excessive [Ca2+]i. [Ca2+]i acts in AD via excessive calcium signaling and the peroxynitrite/oxidative stress/inflammation pathway which are each elevated by EMFs. An apparent vicious cycle in AD involves amyloid-beta protein (A□) and [Ca2+]i. Three types of epidemiology each suggest EMF causation of AD including early onset AD. Extensive animal model studies show that low intensity EMFs cause neurodegeneration including AD, with AD animals having elevated levels of A□, amyloid precursor protein and BACE1. Rats exposed to pulsed EMFs every day are reported to develop universal or near universal very very very early onset neurodegeneration including AD; these findings are superficially similar to humans with digital dementia. EMFs producing modest increases in [Ca2+]i can also produce protective, therapeutic effects. The therapeutic pathway and peroxynitrite pathway inhibit each other. A summary of 18 different findings is provided, which collectively provide powerful evidence for EMF causation of AD. The author is concerned that smarter, more highly pulsed "smart" wireless communication may cause widespread very, very early onset AD in human populations.

https://pubmed.ncbi.nlm.nih.gov/35114921/

MEASUREMENTS OF RADIOFREQUENCY ELECTROMAGNETIC FIELDS, INCLUDING 5G, IN THE CITY OF COLUMBIA, SC, USA

Tarmo Koppel, Lennart Hardell. Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, SC, USA. World Academy of Sciences Journal 4(3):23. 2022. doi: 10.3892/wasj.2022.157.

Abstract

The present study aimed to characterize the wireless infrastructure and public exposure to radiofrequency (RF) electromagnetic fields, including the sub-millimeter wave 5G, in the city center of Columbia, SC, USA. A downtown measurement route was designed to cover popular outdoor areas, including business, recreational and shopping areas. The route was measured five times during different days and times. An exposimeter, was used to cover all the main civilian wireless broadcasting and downlink sources in frequencies 88-5,850 MHz. The measurement route at the streets and squares calculated 1.240 V/m as a mean exposure (total as a sum of all frequency bands) and 6.867 V/m as all times maximum. The most common contributors to the exposure budget were bands FM US, 14DL, 27DL, 25DL and 66DL - mainly indicating 4G. The exposure levels were found to be 12-16% lower during weekends as compared to business hours ($P<0.001$). The spatial analysis of the field distribution revealed 15-20 hotspot areas. A number of hotspots were found where cell phone base station antennas were mounted on top of the utility poles and therefore positioned at low levels, close to street level. On the whole, the findings of the present study suggest that cell phone base station antennas should be distinct and noticeable, as this would assist individuals who need to limit their exposure by distancing themselves from RF sources.

Excerpt

In conclusion, in the city of Columbia, SC, USA, the present study determined that the highest exposure areas were due to two reasons: i) Cell phone base station antennas on top of high-rise buildings provide good cell coverage reaching far away, but creating elevated public exposure to the RF RMFs at the immediate vicinity; and ii) cell phone base station antennas installed on top of the utility poles have placed the radiation source closer to humans walking on the street level.

RF exposure levels from mobile phone base station antennas near the street level reached high levels. It is thus recommended, that all such close proximity transmitters should be labeled with relevant signs to warn of high RF exposure in the area (24). Cell phone base station antennas should be distinct and noticeable so that people who need to limit their exposure, have been given a chance to do so by distancing themselves from the RF sources. Considering the current trend of cell phone service providers expanding their 5G network, more utility pole base station antennas are expected. Consequently, the public exposure is also likely to increase in the coming years.

Open access paper: https://www.spandidos-publications.com/10.3892/wasj.2022.15

PHYSIOLOGICAL CHANGES AND SYMPTOMS ASSOCIATED WITH SHORT-TERM EXPOSURE TO ELECTROMAGNETIC FIELDS: A RANDOMIZED CROSSOVER PROVOCATION STUDY

Po-Chang Huang, Jui-Chin Chiang, Ya-Yun Cheng, Tain-Junn Cheng, Chien-Yuan Huang, Ya-Ting Chuang, Ti Hsu, How-Ran Guo. Physiological changes and symptoms associated with short-term exposure to electromagnetic fields: a randomized crossover provocation study. Environ Health. 2022 Mar 8;21(1):31. doi: 10.1186/s12940- 022-00843-1.

Abstract

Background: The biological association between electromagnetic fields (EMF) and idiopathic environmental intolerance attributed to EMF (IEI-EMF) has not been established. To assess the physiological changes and symptoms associated with exposure to EMF, we conducted a randomized crossover provocation study.

Methods: We recruited 58 individuals with IEI-EMF (IEI-EMF group) and 92 individuals without IEI-EMF (control group). In a controlled environment, all participants received EMF signals mimicking those from mobile phone base stations in a randomized sequence under the blinded condition. During the course, participants reported their symptoms and whether they perceived EMF, and we monitored their physiological parameters, including blood pressure (BP), heart rate (HR), and HR variability.

Results: The IEI-EMF and control groups reported similar frequencies of symptoms during both the provocation and sham sessions. No participant could accurately identify the provocation. In both groups, physiological parameters were similar between the two sessions. The control group, but not the IEI-EMF group, had elevated HR when they perceived EMF exposure.

Conclusions: No symptoms or changes in physiological parameters were found to be associated with short-term exposure to EMF, and no participant could accurately detect the presence of EMF. Moreover, the participants in the control group, but not those in the IEI-EMF group, had elevated HR when they perceived EMF.

Open access paper: https://ehjournal.biomedcentral.com/articles/10.1186/s12940-022-00843-1

LONGITUDINAL STUDY OF EXPOSURE TO RADIO FREQUENCIES AT POPULATION SCALE

Yanis Boussad, Xi (Leslie) Chen, Arnaud Legout, Augustin Chaintreau, Walid Dabbous. Longitudinal study of exposure to radio frequencies at population scale. Environment International. Volume 162, 2022. doi: 10.1016/j.envint.2022.107144.

Abstract

Evaluating exposure to radio frequencies (RF) at population-scale is important for conducting sound epidemiological studies about possible health impact of RF radiations. Numerous studies reported population exposure to RF radiations used in wireless telecommunication technologies, but used very small population samples. In this context, the real exposure of the population at scale remains poorly understood. Here, to the best of our knowledge, we report the largest crowd-based measurement of population exposure to RF produced by cellular antennas, Wi-Fi access points, and Bluetooth devices for 254,410 unique users in 13 countries from January 2017 to December 2020. First, we present methods to assess the

population exposure to RF radiations using smartphone measurements obtained using the ElectroSmart Android app. Then, we use these methods to evaluate and characterize the evolution of RF exposure. We show that total exposure has been multiplied by 2.3 in the four-year period considered, with Wi-Fi as the largest contributor. The cellular exposure levels are orders of magnitude lower than regulation limits and are not correlated to national regulation policies. The population tends to be more exposed at home; for half of the study subjects, personal Wi-Fi routers and Bluetooth devices contributed to more than 50% of their total exposure. In this work, we showcase how crowdsource-based data allow large-scale and long-term assessment of population exposure to RF radiations.

Excerpts Limitations

... First, we only measured the downlink received by the measuring smartphone. Therefore, the contribution of the uplink to the exposure, that is, the emission of the measuring smartphone, is not considered in this study. Also, we did not measure the uplink of surrounding devices Second, the minimum and maximum measurable power for each wireless technology is capped by the Android API and the technology standards Third, for 2G,3G, and 4G, the RSSI is provided by the Android API as an Arbitrary Strength Unit (ASU), an integer value between 0 and 31. It is converted to dBm Fourth, each wireless technology comes with some additional limitations Fifth, the received power was measured using the Received Signal Strength Indicator (RSSI).

Therefore, our measurements do not take into account the effective load of the wireless channel Last, ElectroSmart can only measure radio frequencies produced by Wi-Fi access points, Bluetooth devices and cell towers. It does not measure radio frequencies emitted by other sources such as FM radio or TV ...

Conclusion

In this paper, we presented the largest crowd-based measurement of population exposure to RF produced by cellular antennas, Wi-Fi access points, and Bluetooth devices for 254,410 unique users in 13 countries from January 2017 to December 2020. We showcased the strength of using crowdsource data from mobile smartphones in performing a large-scale and long-term assessment of population exposure to RF radiations. This enabled us to assess the impact of various factors on the exposure using a uniform methodology, which facilitates cross-population and cross-environment analysis. We showed that total exposure has been multiplied by 2.3 in the four-year period considered, with Wi-Fi as the largest contributor. The cellular exposure levels are orders of magnitude lower than regulation limits and are not correlated to national regulation policies. The population tends to be more exposed at home; for half of the study subjects, personal Wi-Fi routers and Bluetooth devices contributed to more than 50% of their total exposure.

An interesting next step would be to consider how the deployment of 5G impacts population exposure. Indeed, in this study, we did not consider 5G as its deployment in the considered countries was small and few smartphones supported 5G before 2021. 5G comes with its own challenges for the evaluation of exposure: it uses small cells, millimeter waves, and beam forming, which changes exposure during transmission. This will undoubtedly be a challenge to correctly characterize exposure to 5G.

Open access paper: https://www.sciencedirect.com/science/article/pii/S0160412022000708

METHODOLOGY FOR DETERMINING THE THRESHOLD DISTANCE FOR ESTIMATING THE MAIN EM EXPOSURE CONTRIBUTION IN WLAN

Marta Fernández, David Guerra. Methodology for determining the threshold distance for estimating the main EM exposure contribution in WLAN. Engineering Science and Technology, an International Journal. Volume 25, 2022, 100997, doi: 10.1016/j.jestch.2021.05.001.

Abstract

The location of radiation sources in wireless networks is a key factor to characterize their contribution to electromagnetic exposure levels in order to deploy future networks that account for minimizing electromagnetic field levels. In relation to wireless local area networks, considering that mobile communication devices comply with the SAR (Specific Absorption Rate) limits imposed by the international standardization organizations for preserving human health, the interest is nowadays focused on the signal levels coming from the WiFi access points. This paper presents a methodology to determine the threshold distance at which the field strength levels from the AP are negligible in comparison with the radiation generated by a user equipment. The theoretical concepts, which can be applied to other technologies, were implemented by means of simulations and experimental measurements. For the simulations, actual WiFi antennas were modelled. Experimental measurements completed the results obtained in simulations, resulting in a greater number of real situations.

Results showed that the threshold distance depends on the WiFi standard employed by the devices connected to the network.

https://www.sciencedirect.com/science/article/pii/S2215098621001099

DIRECTED-ENERGY WEAPONS RESEARCH BECOMES OFFICIAL [HEALTH MATTERS]

J. C. Lin. Directed-Energy Weapons Research Becomes Official [Health Matters]. IEEE Microwave Magazine, 23(4):13-90, April 2022, doi: 10.1109/MMM.2021.3136666.

Abstract

The incidents of sonic attacks on diplomatic personnel in Havana, Cuba, will likely remain a mystery until a culprit is found in the act. The one-time diplomatic affair, the Havana Syndrome, has apparently morphed into a weapons research program in the United States [1]. Indeed, it appears that research in high-power microwaves has persisted worldwide including that undertaken by some of the major military powers [2], [3].

https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9724666&isnumber=9724626

RESPONSE TO THE LETTER BY FOSTER, CHOU, AND CROFT [SPEAKER'S CORNER]

J. C. Lin. Response to the Letter by Foster, Chou, and Croft [Speaker's Corner]. IEEE Microwave Magazine, 23(4): 95, April 2022, doi: 10.1109/MMM.2022.3147174.

Abstract

I appreciate the letter from Foster, Chou, and Croft expressing their concerns about my recent article on health safety guidelines for RF exposures [1]. The letter is understandable, given its authors strong convictions that there is nothing but heat to worry about with RF exposure. In the interest of clarity, I will respond to the writers' three points in their order of presentation.

https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9724675&isnumber=9724626

EXPOSURE TO 1800 MHZ LTE ELECTROMAGNETIC FIELDS UNDER PROINFLAMMATORY CONDITIONS DECREASES THE RESPONSE STRENGTH AND INCREASES THE ACOUSTIC THRESHOLD OF AUDITORY CORTICAL NEURONS

Samira Souffi, Julie Lameth, Quentin Gaucher, Délia Arnaud-Cormos, Philippe Lévêque, Jean-Marc Edeline, Michel Mallat. Exposure to 1800 MHz LTE electromagnetic fields under proinflammatory conditions decreases the response strength and increases the acoustic threshold of auditory cortical neurons. Sci Rep. 2022 Mar 8;12(1):4063. doi: 10.1038/s41598-022-07923-9.

Abstract

Increased needs for mobile phone communications have raised successive generations (G) of wireless technologies, which could differentially affect biological systems. To test this, we exposed rats to single head- only exposure of a 4G long-term evolution (LTE)-1800 MHz electromagnetic field (EMF) for 2 h. We then assessed the impact on microglial space coverage and electrophysiological neuronal activity in the primary auditory cortex (ACx), under acute neuroinflammation induced by lipopolysaccharide. The mean specific absorption rate in the ACx was 0.5 W/kg. Multiunit recording revealed that LTE-EMF triggered reduction in the response strength to pure tones and to natural vocalizations, together with an increase in acoustic threshold in the low and medium frequencies. Iba1 immunohistochemistry showed no change in the area covered by microglia cell bodies and processes. In healthy rats, the same LTE-exposure induced no change in response strength and acoustic threshold. Our data indicate that acute neuroinflammation sensitizes neuronal responses to LTE-EMF, which leads to an altered processing of acoustic stimuli in the ACx.

Excerpt

In conclusion, our study reveals that a single head-only exposure to LTE-1800 MHz can interfere with the neuronal responses of cortical neurons to sensory stimuli. In line with previous characterizations of the effect of GSM-signal, our results show that the impact of LTE signal on neuronal activity varies according to the health state. Acute neuroinflammation sensitize neuronal responses to LTE-1800 MHz, resulting in altered cortical processing of auditory stimuli.

Open access paper: https://www.nature.com/articles/s41598-022-07923-9

CHANGES IN THE EXCITABILITY OF PRIMARY HIPPOCAMPAL NEURONS FOLLOWING EXPOSURE TO 3.0 GHZ RADIOFREQUENCY ELECTROMAGNETIC FIELDS

Ibtissam Echchgadda, Jody C Cantu, Gleb P Tolstykh, Joseph W Butterworth, Jason A Payne, Bennett L Ibey. Changes in the excitability of primary hippocampal neurons following exposure to 3.0 GHz radiofrequency electromagnetic fields. Sci Rep. 2022 Mar 3;12(1):3506. doi: 10.1038/s41598-022-06914-0.

Abstract

Exposures to radiofrequency electromagnetic fields (RF-EMFs, 100 kHz to 6 GHz) have been associated with both positive and negative effects on cognitive behavior. To elucidate the mechanism of RF-EMF interaction, a few studies have examined its impact on neuronal activity and synaptic plasticity. However, there is still a need for additional basic research that further our understanding of the underlying mechanisms of RF-EMFs on the neuronal system. The present study investigated changes in neuronal activity and synaptic transmission

following a 60-min exposure to 3.0 GHz RF-EMF at a low dose (specific absorption rate (SAR) < 1 W/kg). We showed that RF-EMF exposure decreased the amplitude of action potential (AP), depolarized neuronal resting membrane potential (MP), and increased neuronal excitability and synaptic transmission in cultured primary hippocampal neurons (PHNs). The results show that RF-EMF exposure can alter neuronal activity and highlight that more investigations should be performed to fully explore the RF-EMF effects and mechanisms.

Excerpt

In conclusion, our study does not provide sufficient evidence to support nor to refute RF-EMF non-thermal mechanism of interaction. However, the results described here are consistent with previous in vitro studies of influence of RF-EMF exposure on neuronal activity. Moreover, although our investigation of RF-EMF effects is on a simple cultured system, and thus cannot directly correlate to human level responses, the results appear to support the implication of changes of neuronal activity as a cellular mechanism that could potentially underlie RF-EMF mediated changes in cognitive function. Future studies need to compare changes from other conditions including, SAR dose–response, short, repetitive or long-term exposure duration, CW or pulsed signals, as well as verify the duration or recovery of the effects, as reversible electrophysiological changes can occur without adverse health effects.

Open access paper: https://www.nature.com/articles/s41598-022-06914-0

MEASUREMENT AND PREDICTION OF ELECTROMAGNETIC RADIATION EXPOSURE LEVEL IN A UNIVERSITY CAMPUS

Esin Karpat, M. Rafet Bakcan. Measurement and Prediction of Electromagnetic Radiation Exposure Level in a University Campus. Tehnički vjesnik, Vol. 29 No. 2, 2022. doi: 10.17559/TV-20200418183308.

Abstract

The importance of electromagnetic (EM) sources in human life has been increasing with the development of technology. EM radiation triggers some problems in our life such as EM interference and human health problems. EM radiation level which is emitted by the base station increases in proportion to the density of population in a region. EM exposure is higher in areas where people are highly concentrated such as hospitals, military barracks, schools, shopping malls, than in any other region. It is important to show sustained concern about the EM radiation intensity in these areas to keep the levels under the permissible limits. In this study, electric field values are measured statically at locations where the population density is too high, to examine the electric field intensity levels throughout the campus. Besides, two different artificial neural models (ANN) are developed to estimate the electric field values of random locations which are specific regions for electromagnetic exposure. Moreover, measurement results and estimated results are evaluated within the limits defined by national (ICTA) and international (ICNIRP) standards. Finally, the EM exposure map is constructed with data that is average electric field intensity versus measurement locations.

Excerpt

Measurements in the campus show that the maximum EMF value is 4.314 V/m while the minimum is 0.084 V/m. Also, the standard deviation value of the EMF level is 1.157 V/m while the average EMF level is 1.024 V/m. The average electric value measured around two base

stations on the campus is 3.85 V/m while the average electric field value of other locations is 1.153 V/m.

According to these data, it is determined that the contribution of locations, which are near the base station is approximately 300% higher than the other locations.

Open access paper: https://hrcak.srce.hr/272595

NEAR FIELD RADIO FREQUENCY ELECTROMAGNETIC FIELD EXPOSURE OF A WESTERN HONEY BEE

D. Toribio, W. Joseph, A. Thielens. Near Field Radio Frequency Electromagnetic Field Exposure of a Western Honey Bee. IEEE Transactions on Antennas and Propagation. 70(2): 1320-1327. Feb. 2022, doi: 10.1109/TAP.2021.3111286.

Abstract

It has been suggested that the wireless network evolution to smaller carrier wavelengths (from 2G to 5G) increases radio frequency electromagnetic field (RF-EMF) absorption in western honey bees (Apis mellifera). It is unknown whether the radiation performance of antennas is stable when an insect appears in their vicinity. In this research, the absorbed power in a worker honey bee and the influence of the bee's presence on antennas' radiation performance are investigated for the newly used frequencies in 5G networks from 6 to 240 GHz. To these aims, numerical simulations using the finite-difference time-domain (FDTD) method were performed, in which a bee model, obtained by micro-CT scanning, was employed. These simulations showed that, in the near field, the absorbed power can increase by a factor of 53 from 6 to 240 GHz. This is a factor of 7 higher than the increase reported in the far-field in previous studies. Furthermore, the simulations revealed that antennas' radiation efficiency can decrease by up to −40% when a bee appears in the near field. Likewise, it was found that the gain pattern depends on the separation distance between the bee and the antenna with a stronger dependency for higher frequencies.

Conclusion

Numerical simulations using FDTD analysis were executed to calculate the RF-EMFs in and around a worker Western Honey Bee (Apis mellifera). This lead to the quantification of the whole-body averaged absorbed radio- frequency power Pabs, under near-field exposure, in the frequency range of 6–240 GHz. The simulations showed that, in the near field, Pabs decreases as the separation distance between the bee and the dipole increases and increases as frequency increases. The frequency behavior of Pabs in the near field is, thus, different from its far field behavior, since, for a given accepted power and distance, in the near field Pabs increases with frequency (an average of 30.5 dB from 6 to 240 GHz), while, in the far field, Pabs in the worker bee is maximized at 12 GHz. This near-field increase in Pabs as a function of frequency can be a factor of 7 higher than the far-field increase.

Moreover, these simulations allowed the study of the influence of the bee's position (0.1λ – 10λ from the dipoles) in the radiation performance of the dipoles. In particular, it was found that, as the separation distance increases, the dipoles' isotropic gain decreases and approaches their free-space gain. Also, it was noted that, as a result of the near-field frequency behavior of Pabs, the dipoles' radiation efficiency decreases with increasing

frequency and increases with increasing separation distance. In addition, it was acknowledged that the gain pattern in the direction where the bee approaches the antenna depends on the separation distance between the bee and the antenna with a stronger dependency for higher frequencies. This is important for 5G telecommunication networks because they rely on infrastructure (antennas) whose performance can be influenced by the presence of free-flying insects.

Future directions of this research project will include the experimental validation of the results from the simulations presented in this article by completing near-field RF-EMF exposure measurements of honey bees. Furthermore, the RF-EMF interactions between honey bees and phased arrays will be investigated since these are the type of antennas being deployed in high-frequency telecommunication networks. In addition, we aim to investigate the thermal increase in the bee due to near-field and far-field RF-EMF exposure, as a function of frequency, for instance, by means of infrared temperature measurements. Moreover, future work will also consist of performing simulations with heterogeneous honey bee phantoms with tissue-specific dielectric properties.
https://ieeexplore.ieee.org/document/9539081

EXPOSURE TO 1.8 GHZ RADIOFREQUENCY FIELD MODULATES ROS IN HUMAN HEK293 CELLS AS A FUNCTION OF SIGNAL AMPLITUDE

Marootpong Pooam, Nathalie Jourdan, Blanche Aguida, Cyril Dahon, Soria Baouz, Colin Terry, Haider Raad, Margaret Ahmad. Exposure to 1.8 GHz radiofrequency field modulates ROS in human HEK293 cells as a function of signal amplitude. Communicative & Integrative Biology, 15:1, 54-66, 2022, doi: 10.1080/19420889.2022.2027698.

Abstract

The modern telecommunications industry is ubiquitous throughout the world, with a significant percentage of the population using cellular phones on a daily basis. The possible physiological consequences of wireless emissions in the GHz range are therefore of major interest, but remain poorly understood. Here, we show that exposure to a 1.8 GHz carrier frequency in the amplitude range of household telecommunications induces the formation of ROS (Reactive Oxygen Species) in human HEK293 cultured cells. The ROS concentrations detected by fluorescent imaging techniques increased significantly after 15 minutes of RF field exposure, and were localized to both nuclear and cytosolic cellular compartments. qPCR analysis showed altered gene expression of both anti-oxidative (SOD, GPX, GPX, and CAT) and oxidative (Nox-2) enzymes. In addition, multiple genes previously identified as responsive to static magnetic fields were found to also be regulated by RF, suggesting common features in response mechanisms. By contrast, many RF effects showed evidence of hormesis, whereby biological responsivity does not occur linearly as a function of signal amplitude. Instead, biphasic dose response curves occur with 'blind' spots at certain signal amplitudes where no measureable response occurs. We conclude that modulation of intracellular ROS can be a direct consequence of RF exposure dependent on signal frequency and amplitude. Since changes in intracellular ROS may have both harmful and beneficial effects, these could provide the basis for many reported physiological effects of RF exposure.

Conclusion

In conclusion, we show that exposure to RF within the amplitude range emitted by household telecommunication devices can have a direct and immediate physiological effect on cellular ROS biosynthesis and signaling. This response is dependent in complex ways on RF signal amplitude, consistent with a biological receptor mediated process. The response to RF further shares common features with modulation of ROS by static magnetic fields. Since ROS regulates oxidative stress and cellular signaling and response pathways, our results provide a possible mechanistic explanation for the many different reported physiological effects of RF in the literature.

https://www.tandfonline.com/doi/full/10.1080/19420889.2022.2027698

GENDER DIFFERENCES IN EFFECTS OF PRENATAL AND POSTNATAL EXPOSURE TO ELECTROMAGNETIC FIELD AND PRENATAL ZINC ON BEHAVIOUR AND SYNAPTIC PROTEINS IN RATS

Burcu Acikgoz, Nevin Ersoy, Ilkay Aksu, Amac Kiray, Husnu Alper Bagriyanik, Muge Kiray. Gender differences in effects of prenatal and postnatal exposure to electromagnetic field and prenatal zinc on behaviour and synaptic proteins in rats. J Chem Neuroanat. 2022 Mar 29;122:102092. doi: 10.1016/j.jchemneu.2022.102092.

Highlights

- Electromagnetic field (EMF) exposure may affect the levels of synaptic proteins in the developing brain.
- EMF exposure has no effect on social behaviour but may affect activity and anxiety.
- Zinc supplementation has a partially positive effect on female, but not male rats.

Abstract

Humans are exposed to electromagnetic fields (EMF) from various sources throughout life. Because humans are easily impacted by environmental factors during early development, it is believed that EMF can cause structural and functional changes on the developing brain that may lead to behavioural changes. This paper investigates the impact of EMF exposure and zinc supplementation during the prenatal and postnatal periods on behavioural changes and synaptic proteins in a gender-dependent manner. Pups from four groups of pregnant rats were used: Sham, EMF (5 days/wk, 4 h/day EMF-exposure applied), Sham+Zinc (5 days/wk, 5 mg/kg/day zinc applied) and EMF+Zinc (5 days/wk, 4 h/day EMF-exposure and 5 mg/kg/day zinc applied). EMF exposure and zinc supplementation were initiated from the first day of pregnancy to the 42nd postnatal day. Zinc levels in blood, NLGN3 and SHANK3 levels in hippocampus and amygdala, and synaptic structures in amygdala were examined. Behavioural tests showed that EMF exposure had no effect on social behaviour, but adversely affected activity and exploratory behaviour, and led to increased anxiety formation. Zinc supplementation had a partially positive effect on female, but not male offspring. SHANK3 and NLGN3 proteins were significantly lower in EMF groups, however, no positive effect of zinc supplementation was found. In conclusion, EMF exposure may alter the levels of synaptic proteins in the developing brain, leading to behavioural changes in a gender-dependent manner.

Evaluation of zinc supplementation at different doses could be beneficial to prevent or reduce the behavioural and structural effects of EMF. https://pubmed.ncbi.nlm.nih.gov/35364275/

LONG-TERM WI-FI EXPOSURE FROM PRE-PUBERTAL TO ADULT AGE ON THE SPERMATOGONIA PROLIFERATION AND PROTECTIVE EFFECTS OF EDIBLE BIRD'S NEST SUPPLEMENTATION

Farah Hanan Fathihah Jaffar, Khairul Osman, Chua Kien Hui, Aini Farzana Zulkefli, Siti Fatimah Ibrahim. Long- Term Wi-Fi Exposure From Pre-Pubertal to Adult Age on the Spermatogonia Proliferation and Protective Effects of Edible Bird's Nest Supplementation. Front Physiol. 2022 Mar 11;13:828578. doi: 10.3389/fphys.2022.828578.

Abstract

Children are vulnerable to the radiofrequency radiation (RFR) emitted by Wi-Fi devices. Nevertheless, the severity of the Wi-Fi effect on their reproductive development has been sparsely available. Therefore, this study was conducted to evaluate the Wi-Fi exposure on spermatogonia proliferation in the testis. This study also incorporated an approach to attenuate the effect of Wi-Fi by giving concurrent edible bird's nest (EBN) supplementation. It was predicted that Wi-Fi exposure reduces spermatogonia proliferation while EBN supplementation protects against it. A total of 30 (N = 30) 3-week-old Sprague Dawley weanlings were divided equally into five groups; Control, Control EBN, Wi-Fi, Sham Wi-Fi, and Wi-Fi + EBN. 2.45 GHz Wi-Fi exposure and 250 mg/kg EBN supplementation were conducted for 14 weeks. Findings showed that the Wi-Fi group had decreased in spermatogonia mitosis status. However, the mRNA and protein expression of c-Kit-SCF showed no significant decrease. Instead, the reproductive hormone showed a reduction in FSH and LH serum levels. Of these, LH serum level was decreased significantly in the Wi-Fi group. Otherwise, supplementing the Wi-Fi + EBN group with 250 mg/kg EBN resulted in a significant increase in spermatogonia mitotic status. Even though EBN supplementation improved c-Kit-SCF mRNA and protein expression, the effects were insignificant. The improvement of spermatogonia mitosis appeared to be associated with a significant increase in blood FSH levels following EBN supplementation. In conclusion, the long-term Wi-Fi exposure from pre-pubertal to adult age reduces spermatogonia proliferation in the testis. On the other hand, EBN supplementation protects spermatogonia proliferation against Wi-Fi exposure.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8963498/

EXPOSURE TO MAGNETIC FIELDS AND CHILDHOOD LEUKEMIA: A SYSTEMATIC REVIEW AND META-ANALYSIS OF CASE-CONTROL AND COHORT STUDIES

Christian Brabant, Anton Geerinck, Charlotte Beaudart, Ezio Tirelli, Christophe Geuzaine and Olivier Bruyère. Exposure to magnetic fields and childhood leukemia: a systematic review and meta-analysis of case-control and cohort studies. Reviews on Environmental Health. Published online March 15, 2022. doi: 10.1515/reveh-2021- 0112.

Abstract

The association between childhood leukemia and extremely low frequency magnetic fields (ELF-MF) generated by power lines and various electric appliances has been studied extensively during the past 40 years. However, the conditions under which ELF-MF represent a risk factor for leukemia are still unclear. Therefore, we have performed a systematic review and meta-analysis to clarify the relation between ELF-MF from several sources and childhood

leukemia. We have systematically searched Medline, Scopus, Cochrane Database of Systematic Review and DARE to identify each article that has examined the relationship between ELF-MF and childhood leukemia. We have performed a global meta-analysis that takes into account the different measures used to assess magnetic field exposure: magnetic flux density measurements (<0.2 μT vs. >0.2 μT), distances between the child's home and power lines (>200 m vs. <200 m) and wire codings (low current configuration vs. high current configuration). Moreover, meta-analyses either based on magnetic flux densities, on proximity to power lines or on wire codings have been performed. The association between electric appliances and childhood leukemia has also been examined. Of the 863 references identified, 38 studies have been included in our systematic review. Our global meta-analysis indicated an association between childhood leukemia and ELF-MF (21 studies, pooled OR=1.26; 95% CI 1.06–1.49), an association mainly explained by the studies conducted before 2000 (earlier studies: pooled OR=1.51; 95% CI 1.26–1.80 vs. later studies: pooled OR=1.04; 95% CI 0.84– 1.29). Our meta-analyses based only on magnetic field measurements indicated that the magnetic flux density threshold associated with childhood leukemia is higher than 0.4 μT (12 studies, >0.4 μT: pooled OR=1.37; 95% CI 1.05–1.80; acute lymphoblastic leukemia alone: seven studies, >0.4 μT: pooled OR=1.88; 95% CI 1.31–2.70).

Lower magnetic fields were not associated with leukemia (12 studies, 0.1–0.2 μT: pooled OR=1.04; 95% CI 0.88– 1.24; 0.2–0.4 μT: pooled OR=1.07; 95% CI 0.87–1.30). Our meta-analyses based only on distances (five studies) showed that the pooled ORs for living within 50 m and 200 m of power lines were 1.11 (95% CI 0.81–1.52) and 0.98 (95% CI 0.85–1.12), respectively. The pooled OR for living within 50 m of power lines and acute lymphoblastic leukemia analyzed separately was 1.44 (95% CI 0.72–2.88). Our meta-analyses based only on wire codings (five studies) indicated that the pooled OR for the very high current configuration (VHCC) was 1.23 (95% CI 0.72–2.10). Finally, the risk of childhood leukemia was increased after exposure to electric blankets (four studies, pooled OR=2.75; 95% CI 1.71–4.42) and, to a lesser extent, electric clocks (four studies, pooled OR=1.27; 95% CI 1.01–1.60). Our results suggest that ELF-MF higher than 0.4 μT can increase the risk of developing leukemia in children, probably acute lymphoblastic leukemia. Prolonged exposure to electric appliances that generate magnetic fields higher than 0.4 μT like electric blankets is associated with a greater risk of childhood leukemia.

Excerpt

Our results have practical implications. Our meta-analysis suggests that exposure to residential magnetic fields higher than 0.4 μT can increase the risk of leukemia in children. Nevertheless, it is important to emphasize the fact that very few homes are exposed to magnetic fields higher than 0.4 μT generated by overhead power lines in high income countries [11, 30]. Moreover, the annual incidence of childhood leukemia is very low and ranges between 35 and 50 cases per million children in western European countries and North America [69]. Since the absolute risk of childhood leukemia is very low and children are rarely continuously exposed to magnetic fields higher than 0.4 μT in high income countries, the increased leukemia risk found in our meta-analysis does not represent a major public health concern in these countries. Magnetic flux densities higher than 0.4 μT are usually within 50 m of overhead power lines [11] even if Crespi et al. [30] found some subjects living between 50 and 200 m away from overhead power lines (over 200 kV) that were exposed to ELF-MF higher than 0.4 μT. Magnetic flux density measurements should be performed if children live within

200 m of overhead power lines to guarantee that they are not exposed to ELF-MF higher than 0.4 μT. In contrast, living more than 200 m away from overhead power lines could be considered a safe distance for children that is not linked to a higher leukemia risk. Our systematic review suggests that children from middle income countries like Mexico and Iran are more likely to be exposed to magnetic fields above 0.4 μT and the risk of leukemia attributable to ELF-MF is probably higher in these countries. It is noteworthy that none of the studies included in our review have been performed in low income countries or in Africa. More research on ELF-MF and childhood leukemia is needed in these countries, particularly in African countries.

Our meta-analyses suggest that exposure to electric appliances like electric blankets and bedside electric clocks increase the risk of leukemia in children. However, it is important to note that the studies that have found an association between these electric appliances and childhood leukemia have been performed more than 20 years ago and our findings should be interpreted based on the electric equipment used today. Electric blankets and bedside electric clocks used at the end of the twentieth century could generate magnetic fields higher than 0.4 μT and children were typically exposed to these electric appliances during several hours in a row [67]. In contrast, hair dryers can also generate magnetic fields higher than 0.4 μT but are usually used during a shorter period of time [67] and we did not find a significant association between the use of hair dryers and childhood leukemia. These findings are relevant today in the sense that the duration of exposure to ELF-MF plays a role and that children should not be exposed to electric appliances that generate magnetic fields higher than 0.4 μT during long periods of time. Importantly, Magne and colleagues [70] have measured personal exposure to ELF- MF in French children between 2007 and 2009. They have found that alarm clocks were the main variable linked to the magnetic field exposure of the children. The proportion of children exposed to magnetic fields higher than 0.4 μT was 3.1% when all children were included in the analysis and 0.8% when the analysis was restricted to children for which no alarm clock had been identified. Taken together, these results and ours suggest that “bedside” electric clocks and alarm clocks that generate magnetic fields higher than 0.4 μT at close distance should be located at least 1 m away from the bed of the child, because the magnetic flux density generated by electric clocks was lower than 0.4 μT at this distance in the study by Preece et al. [71]. To the best of our knowledge, there is no recent update of the study by Behrens et al. [67] that has performed reliable magnetic flux density measurements for electric appliances manufactured recently that generate ELF-MF. Studies with reliable exposure characterization with respect to sources of ELF-MF are needed, especially for the electric appliances manufactured recently that we use on a daily basis.

In summary, our study suggests that exposure to ELF-MF higher than 0.4 μT increases the risk of developing leukemia in children. Acute lymphoblastic leukemia is probably the subtype of leukemia associated with ELF-MF. Prolonged exposure to electric appliances that generate magnetic fields higher than 0.4 μT like electric blankets is associated with a more elevated risk of childhood leukemia. The distance from power lines linked to leukemia is difficult to determine but living more than 200 m away from power lines is likely a safe distance for children not associated with a higher leukemia risk.

https://pubmed.ncbi.nlm.nih.gov/35302721/

MAGNETIC FIELDS AND CANCER: EPIDEMIOLOGY, CELLULAR BIOLOGY, AND THERANOSTICS

Massimo E Maffei. Magnetic Fields and Cancer: Epidemiology, Cellular Biology, and Theranostics. International Journal of Molecular Sciences. 2022; 23(3):1339. doi: 10.3390/ijms23031339. (This article belongs to the Special Issue The Effect of Magnetic Fields on Living Organisms: Biomolecular and Cellular Mechanisms)

Abstract

Humans are exposed to a complex mix of man-made electric and magnetic fields (MFs) at many different frequencies, at home and at work. Epidemiological studies indicate that there is a positive relationship between residential/domestic and occupational exposure to extremely low frequency electromagnetic fields and some types of cancer, although some other studies indicate no relationship. In this review, after an introduction on the MF definition and a description of natural/anthropogenic sources, the epidemiology of residential/domestic and occupational exposure to MFs and cancer is reviewed, with reference to leukemia, brain, and breast cancer. The in vivo and in vitro effects of MFs on cancer are reviewed considering both human and animal cells, with particular reference to the involvement of reactive oxygen species (ROS). MF application on cancer diagnostic and therapy (theranostic) are also reviewed by describing the use of different magnetic resonance imaging (MRI) applications for the detection of several cancers. Finally, the use of magnetic nanoparticles is described in terms of treatment of cancer by nanomedical applications for the precise delivery of anticancer drugs, nanosurgery by magnetomechanic methods, and selective killing of cancer cells by magnetic hyperthermia. The supplementary tables provide quantitative data and methodologies in epidemiological and cell biology studies. Although scientists do not generally agree that there is a cause-effect relationship between exposure to MF and cancer, MFs might not be the direct cause of cancer but may contribute to produce ROS and generate oxidative stress, which could trigger or enhance the expression of oncogenes.

Open access paper: https://www.mdpi.com/1422-0067/23/3/1339

POOLED ANALYSIS OF RECENT STUDIES OF MAGNETIC FIELDS AND CHILDHOOD LEUKEMIA

Aryana T. Amoon, John Swanson, Corrado Magnani, Christoffer Johansen, Leeka Kheifets. Pooled analysis of recent studies of magnetic fields and childhood leukemia. Environmental Research. Volume 204, Part A, 2022. doi: 10.1016/j.envres.2021.111993.

Abstract

Background Over forty epidemiologic studies have addressed an association between measured or calculated extremely-low-frequency magnetic fields (MF) and childhood leukemia. These studies have been aggregated in a series of pooled analyses, but it has been 10 years since the last such.

Methods We present a pooled analysis combining individual-level data (24,994 cases, 30,769 controls) from four recent studies on MF and childhood leukemia.

Results Unlike previous pooled analyses, we found no increased risk of leukemia among children exposed to greater MF: odds ratio (OR) = 1.01, for exposure ≥0.4 μT (μT) compared with exposures <0.1 μT. Similarly, no association was observed in the subset of acute lymphoblastic leukemia, birth homes, studies using calculated fields, or when geocoding

accuracy was ignored. In these studies, there is a decline in risk over time, also evident when we compare three pooled analyses. A meta-analysis of the three pooled analyses overall presents an OR of 1.45 (95% CI: 0.95–2.20) for exposures ≥0.4 μT.

Conclusions Our results are not in line with previous pooled analysis and show a decrease in effect to no association between MF and childhood leukemia. This could be due to methodological issues, random chance, or a true finding of disappearing effect.

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https://www.sciencedirect.com/science/article/pii/S0013935121012883

EXTREMELY LOW FREQUENCY ELECTROMAGNETIC FIELDS EXPOSURE DURING THE PRENATAL AND POSTNATAL PERIODS ALTERS PRO-INFLAMMATORY CYTOKINES LEVELS BY GENDER

Ozturk H, Saribal D, Gelmez YM, Deniz G, Yilmaz A, Kirectepe A, Ercan AM. Extremely low frequency electromagnetic fields exposure during the prenatal and postnatal periods alters pro-inflammatory cytokines levels by gender. Electromagn Biol Med. 2022 Mar 2:1-11. doi: 10.1080/15368378.2022.2046045.

Abstract

Maternal exposure to the excessive electromagnetic fields is considered harmful to infants and associated with several health problems in life, such as neurological or immune diseases. In this present study we aimed to investigate the potential effects of extremely low-frequency electromagnetic field (ELF-EMF) exposure during the gestational and lactational period of dams on immune system parameters. The development of white blood cells (WBC), lymphocyte subpopulations (CD4+ T cells, CD8+ T cells, Natural Killer (NK) cells, and B cells) and production of T cell related cytokines were explored in the offsprings. Significant changes were found in WBC and lymphocyte counts. Although no changes in lymphocyte subunits were observed among groups, CD4+ cells were significantly increased in the female group exposed to ELF-EMF. Also, IL-17A and IFN-γ levels increased in plasma and spleen. The mean IL-4 level and the expression level of the IL-4 gene were not changed, in the experimental groups. But the expression of the IL-17A gene was also upregulated, which supports cytokine quantification analyses. In conclusion, ELF-EMF exposure in the prenatal and postnatal period increases the level of IL-17A in the spleen and blood of young female rats, and it upregulates IL-17 gene expression in the spleen, resulting in CD4+ cell proliferation and inflammation.
https://pubmed.ncbi.nlm.nih.gov/35232334/

DO 50/60 HZ MAGNETIC FIELDS INFLUENCE OXIDATIVE OR DNA DAMAGE RESPONSES IN HUMAN SH-SY5Y NEUROBLASTOMA CELLS?

Ehab Mustafa, Leonardo Makinistian, Jukka Luukkonen, Jukka Juutilainen, Jonne Naarala. Do 50/60 Hz magnetic fields influence oxidative or DNA damage responses in human SH-SY5Y neuroblastoma cells? Int J Radiat Biol. 2022 Mar 23;1-35. doi: 10.1080/09553002.2022.2055803.

Abstract

Purpose: We investigated possible effects of 50 Hz and 60 Hz magnetic fields (MFs) on reactive oxygen species (ROS) production, DNA damage, DNA damage repair rate, as well as gene expression related to oxidative stress and DNA damage signaling.

Materials and methods: Human SH-SY5Y neuroblastoma cells were sham-exposed or exposed to 100 μTRMS MFs for 24 h, then assayed or further treated with 100 μM menadione for 1 h before the assay. The levels of ROS and cytosolic superoxide anion (O2•-) were assayed fluorometrically. DNA damage and gene expression were assayed by comet assay and RT-qPCR, respectively. To examine whether MFs affected DNA damage repair rate, cells were allowed to repair their DNA for 1 or 2 h after menadione treatment and then assayed for DNA damage.

Results: There was suggestive evidence of a general low-magnitude increase in the expression of ROS-related genes (primarily genes with antioxidant activity) when quantified immediately after MF exposure, suggesting a response to a small increase in ROS level. The possible upregulation of ROS-related genes is supported by the finding that the level of menadione-induced ROS was consistently decreased by 50 Hz MFs (not significantly by 60 Hz MFs) in several measurements 30 - 60 min after MF exposure. MF exposures did not affect cytosolic O2•- levels, DNA damage, or its repair rate. Changes in the expression of DNA damage-signaling genes in the MF- exposed cells did not exceed the expected rate of false positive findings. No firm evidence was found for differential effects from 50 Hz vs. 60 Hz MFs.

Conclusions: While only weak effects were found on the endpoints measured, the results are consistent with MF effects on ROS signaling. https://pubmed.ncbi.nlm.nih.gov/35320060/

ASSESSMENT OF TWIN FETAL EXPOSURE TO ENVIRONMENTAL MAGNETIC AND ELECTROMAGNETIC FIELDS

Zhang C, Li C, Yang L, Hou W, Du M, Wu T, Chen W. Assessment of Twin Fetal Exposure to Environmental Magnetic and Electromagnetic Fields. Bioelectromagnetics. 2022 Mar 1. doi: 10.1002/bem.22397.

Abstract

Fetal development is vital in the human lifespan. Therefore, it is essential to characterize exposure by a series of typical environmental magnetic and electromagnetic fields. In particular, there has recently been a sharp increase in the twin birth rate. However, lack of appropriate models has prohibited dosimetric evaluation, restricting characterization of the impact of these environmental factors on twins. The present study developed two whole-body pregnant models of 31 and 32 weeks of gestation (WG) with twin fetuses and explored several typical exposure scenarios, including 50-Hz uniform magnetic field exposure, local

125-kHz magnetic field (MF), and 13.56-MHz electromagnetic field exposure, as well as wideband planewave radiofrequency (RF) exposure from 20 to 6000 MHz. Finally, dosimetric results were derived. Compared to the singleton pregnancy with similar weeks of gestation, twin fetuses were overexposed at 50-Hz uniform MF, but they were probably underexposed in the RF scenarios with frequencies for wireless communications. Furthermore, the twin fetuses manifested large dosimetric variability compared to the singleton, which was attributed to the incident direction and fetal position. Based on the analysis, the dosimetric results over the entire gestation period were estimated. The results can be helpful to estimate the risk of twin-fetal exposure to electromagnetic fields and examine the conservativeness of the international guidelines
https://pubmed.ncbi.nlm.nih.gov/35233784/

Conclusion
In the study, we developed two pregnant models with twin fetuses of 31 and 32 WG by MRI images.The dosimetric results have been investigated for several typical scenarios, i.e. 50-Hz uniform MFexposure, EAS local MF exposure, and wide-band whole-body RF exposure. The outcomes were compared against that of the singleton. Overexposure of the twins compared with the singleton at ELF MF and RF exposure at several hundred MHz was observed from the results. Significantly large dosimetric variability was documented.

Although the surveyed configurations indicated that current International Commission On Non-Ionizing Radiation Protection [2010, 2020] were conservative for twin fetuses, these dosimetric characteristics should be considered for epidemiological analysis. The results indicate that future research employing anatomically correct twin-fetal models with various WG is needed.

A systematic review on occupational exposure to radiofrequency electromagnetic fields and risk of cancer: preliminary results from an Italian research project. Alberto Modenese, Giulia Bravo, Carlo Grandi, Mauro Biffoni, Fabriziomaria Gobba. A systematic review on occupational exposure to radiofrequency electromagnetic fields and risk of cancer: preliminary results from an Italian research project. Safety and Health at Work. Volume 13, Supplement: S246. 2022. doi: 10.1016/j.shaw.2021.12.1521.

Abstract
Introduction: The aim of the systematic review (SR) is to evaluate available scientific evidence from human studies on the possible associations between occupational exposure to radiofrequency (RF) electromagnetic fields (EMF) and risk of cancer.

Methods: The SR is part of the Italian research project BRIC 2018 – ID 06, supported by INAIL (PROSPERO code: CRD42020200202), and is conducted according to PRISMA statements. All the studies on workers with documented occupational exposure to RF-EMF (frequency range: 3 kHz - 300 GHz) and medical diagnosis of cancer are considered for inclusion. Original research published in English language in peer-reviewed international journals are included, with no restriction for publication period.

Results: According to a preliminary evaluation of SR results, the studies have been focused on different types of cancer, including brain tumors and various other. A major problem is

that, with the exception of a few studies applying a detailed exposure assessment based on individual RF exposure data, in the large majority of the studies the evaluation of occupational RF-EMF exposure is affected by various types of bias. Moreover, in many of the job categories enrolled in the studies, a co-exposure to other occupational carcinogens is expected, potentially affecting the overall results.

Conclusions: The SR is still ongoing, but preliminary results suggest that the heterogeneity of the available studies, both considering job categories and outcomes evaluation, as well as various bias in the exposure assessment, limits the possibility of a pooled quantitative synthesis of the studies' results.
https://www.sciencedirect.com/science/article/pii/S2093791121016206

MODELLING AND EVALUATING ELECTROMAGNETIC FIELD EXPOSURE IN THE MULTIPLE-SOURCE SCENARIO OF USING IOT HF RFID READERS

Patryk Zradziński. Modelling and Evaluating Electromagnetic Field Exposure in the Multiple-Source Scenario of Using IoT HF RFID Readers. Int J Environ Res Public Health. 2022 Mar 10;19(6):3274. doi: 10.3390/ijerph19063274.

Abstract

The aim of this study was to evaluate Specific Absorption Rate (SAR) and induced electric field (Ein) values in the model of a body of a person present near multiple HF RFID readers of a passive proximity integrated circuit card (PICC) working in an IoT application in a public transport vehicle, in order to test the hypothesis that even the simultaneous use of modelled readers does not cause electromagnetic field (EMF) exposure exceeding relevant limits provided for the evaluation of exposure of the general public. SAR and Ein values were evaluated under various exposure scenarios, designed to mimic EMF exposure under realistic conditions of HF RFID readers used on a public bus and covering various reader locations and the presence of a person using a PICC and a bystander. The results obtained from numerical modelling showed that the absorption of EMF emitted continuously by HF RFID readers (located 10 cm away from a body) in the human body may have a significant influence on humans when the PICC reading ranges are longer than 15-23 cm (depending on the class of PICC) for a single reader and when multiple sources of exposure are used in a public transport vehicle-even at reading ranges 15% shorter (13-20 cm).
Open access paper: https://www.mdpi.com/1660-4601/19/6/3274

ANALYSIS OF RED BLOOD CELL MOVEMENT IN WHOLE BLOOD EXPOSED TO DC AND ELF ELECTRIC FIELDS

Miki Kanemaki, Hisae O Shimizu, Hiroshi Inujima, Takeo Miyake, Koichi Shimizu. Analysis of Red Blood Cell Movement in Whole Blood Exposed to DC and ELF Electric Fields. Bioelectromagnetics. 2022 Apr;43(3):149-159. doi: 10.1002/bem.22395.

Abstract

To evaluate hematological effects of direct current (DC) and alternating current (AC) extremely low frequency (ELF) electric field exposure, this study investigated red blood cell (RBC) movement in whole blood. Video images of RBCs were recorded under a microscope using specially designed electrode systems. Video analysis software was then used to measure the RBC velocity. The noise level and measurement system stability were confirmed

based on results of a no-field exposure experiment. Using the electrode system to produce a non- homogeneous electric field, different movements were found to occur in DC and AC field exposure. The RBCs moved in the directions of the electric field and the gradient of field distribution, respectively, in the DC and AC fields. Dependences of the RBC velocity on the field strength were, respectively, linear and quadratic in the DC and AC fields. These results suggest that electrophoretic and dielectrophoretic movements were, respectively, dominant in the DC and AC fields. The magnitude of the electric field necessary to cause these effects was found to be 103 -105 times greater than the internationally publicized guideline for human safety. https://pubmed.ncbi.nlm.nih.gov/35315542/

COMPLEX ELECTROMAGNETIC ISSUES ASSOCIATED WITH THE USE OF ELECTRIC VEHICLES IN URBAN TRANSPORTATION

Krzysztof Gryz, Jolanta Karpowicz, Patryk Zradziński. Complex Electromagnetic Issues Associated with the Use of Electric Vehicles in Urban Transportation. Sensors (Basel). 2022 Feb 22;22(5):1719. doi: 10.3390/s22051719.

Abstract

The electromagnetic field (EMF) in electric vehicles (EVs) affects not only drivers, but also passengers (using EVs daily) and electronic devices inside. This article summarizes the measurement methods applicable in studies of complex EMF in EVs focused on the evaluation of characteristics of such exposure to EVs users and drivers, together with the results of investigations into the static magnetic field (SMF), the extremely low-frequency magnetic field (ELF) and radiofrequency (RF) EMF related to the use of the EVs in urban transportation. The investigated EMF components comply separately with limits provided by international labor law and guidelines regarding the evaluation of human short-term exposure; however other issues need attention-electromagnetic immunity of electronic devices and long-term human exposure. The strongest EMF was found in the vicinity of direct current (DC) charging installations-SMF up to 0.2 mT and ELF magnetic field up to 100 µT-and inside the EVs-up to 30 µT close to its internal electrical equipment. Exposure to RF EMF inside the EVs (up to a few V/m) was found and recognized to be emitted from outdoor radio communications systems, together with emissions from sources used inside vehicles, such as passenger mobile communication handsets and antennas of Wi-Fi routers.

Excerpts

4.5. Health Aspects of Exposure to EMF in EVs

An EV driver's long-lasting daily exposure to EMF, even if compliant with the exposure limits, cannot be counted to be negligible when the context of possible adverse health effects due to chronic exposure to EMF is considered. The ELF MF was classified to be a possible carcinogenic to human (2B classification) based on the epidemiologically proven elevated carcinogenic health risks in populations chronically exposed to MF exceeding 0.4 µT (attention level related to yearly averaged exposure) [38,39,40]. The level of ELF MF exposure reported in various studies focused on EMF in EVs and discussed in this article may significantly contribute to the total long- lasting exposure to drivers.

The effects of EMF exposure induced in exposed objects are frequency-dependent, but the significant majority of studies performed so far in the area of EMF safety have referred to the

populations exposed to high-voltage power lines (i.e., to chronic exposure to EMF of sinusoidal power frequency), and the outcome of such observations was a base for the abovementioned 2B classification for ELF MF exceeding 0.4 μT. Because of differences in the frequency patterns of the discussed exposures (near power lines and in EVs), there needs to be very careful analysis of how far the studied health and safety outcomes from ELF EMF exposures vary in such cases, and which exposure metrics are relevant to evaluate them. Consistently, the mentioned differences in frequency characteristics of ELF EMF in EVs and EMF near regular electric power installations also need attention with respect to the exposure evaluation protocol, which in practice means that studies of the parameters of EMF exposure associated with the use of EVs require not only measurements of the RMS value (which, in practice, is usually almost equal to the RMS value of the dominant frequency component of exposure), but also attention to the higher harmonics of this exposure, the components of fundamental frequencies other than 50 Hz, the parameters of transient EMF over rapid changes in the mode of EV driving, and combined exposure including the above mentioned components.

Similar to ELF MF, RF EMF was classified by the IARC in the group of 2B carcinogenic environmental factors [41]. This component of driver EMF exposure also needs attention because of its level at least comparable to office exposure, where wireless radio communication facilities are in use and daily long-lasting exposure, potentially significantly contributing to total driver chronic exposure, combines with other components of lower frequencies (covering together exposure to: static, low frequency and radiofrequency fields).

5. Conclusions

In every urban area, there is a daily mass of passengers traveling by public transportation. Ecological and economic reasons, as well as technological development, mean that a significant percentage of the population already use EVs (trams, metro, trolleys, buses) daily, seeing as they are an increasing majority of transportation resources in various large cities. During the journeys, passengers and drivers are exposed to a specific complex EMF, with a dominant ELF component emitted by the driving systems and their supply installations, and an RF component emitted by various wireless communications systems (e.g., Wi-Fi routers located often inside vehicles, handsets of mobile communications used by passengers, and mobile communication BTS located outside vehicles). Depending on the location of the electric equipment inside the EVs, a higher exposure to EMF may affect passengers, or in some cases drivers.

Investigations into SMF, ELF and RF EMF emitted by various electrical equipment associated with the use of EV urban transportation showed that their levels, considered separately, comply with the limits provided by international labor law and guidelines aimed at protecting against the direct effects of short-term influence on humans of EMF of a particular frequency range (set up to prevent thermal load or electrical stimulation in exposed tissue) [12,13,17,20,21,22]. International guidelines and labor law do not provide rules on how to evaluate simultaneous exposure at various frequency ranges (e.g., SMF together with ELF and RF). This needs also specific attention, given that electronic devices and systems used inside EVs need to have sufficient electromagnetic immunity to ensure that their performance is not negatively affected by the impact from EMF emitted by the use of EVs.

Considering the chronic nature of exposure to EMF in EVs (in particular with respect to potential exposure to drivers when various EMF sources are located near their cabins), and the potential specific risks from exposure to EMF of complex composition in time and frequency domains, there is a need to collect research data on the complex characteristics of EMF exposure related to the use of EVs in public transportation and the associated health outcome in chronically exposed workers, as well as decreasing the level of their exposure by applying relevant preventive measures (e.g., locating indoor Wi-Fi routers, and other such electrical equipment, away from the driver's cabin) [17,23,42,43,44].
Open access paper: https://www.mdpi.com/1424-8220/22/5/1719

THE ROLE OF THE AC COMPONENT IN HUMAN PERCEPTION OF AC-DC HYBRID ELECTRIC FIELDS

Kathrin Jankowiak, Andrea Kaifie, Thomas Krampert, Thomas Kraus, Michael Kursawe. The role of the AC component in human perception of AC-DC hybrid electric fields. Sci Rep. 2022 Mar 1;12(1):3391. doi: 10.1038/s41598-022-07388-w.

Abstract

Electric energy is essential to today's society. To cope with global higher demand while minimizing land use, efficient high voltage direct current (HVDC) power lines are planned to be mounted on existing alternating current (AC) structures leading to electric fields (EFs) from both AC and DC transmission lines in hybrid configurations. Due to the close proximity to residential areas, the investigation of human hybrid EF perception and underlying mechanisms will be useful to project permitting. To specify the influence of the AC component on the whole-body detection thresholds of hybrid EFs and to explore the lower bound of human hybrid EF perception, 51 participants with an EF detection ability above average were exposed in a double-blind laboratory study. A psychophysical method based on the signal detection theory was used. Very low EF strength combinations, e.g. 1 kV/m AC combined with 1 kV/m DC, were reliably perceived by at least one participant.

Detection thresholds were significantly lower with increased AC EF strengths, underlining the key role of the AC component in the human perception of hybrid EFs. Findings will contribute to the assessment of public reaction to the perception of EFs around hybrid overhead power lines and to their optimal designs.

Conclusion

Within the current study, we showed that the AC component plays a key role in the human perception of hybrid EFs as increased AC EF strengths lowered detection thresholds of hybrid EFs. Therefore, not only the total EF strength but especially the AC component in a hybrid EF is decisive for estimating hybrid detection thresholds. Focusing on the lower bound of hybrid EF perception, it could be indicated that some people are even able to reliably detect very low hybrid EFs of up to 1 kV/m AC EF combined with 1 kV/m DC EF. This high sensibility, along with the synergistic effect of AC and DC, should be taken into consideration when assessing public reaction to the perception of EFs around hybrid overhead lines. In this context, the effect of environmental factors, such as relative humidity and ion currents, on the perception of low hybrid EFs could be investigated in future studies, as both factors were associated with lower detection thresholds8. Together with these findings, our data will help to prevent

unwanted EF perception in nature and contribute to the construction of future hybrid overhead power lines.
Open access paper: https://www.nature.com/articles/s41598-022-07388-w

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DISTINCT FATTY ACID REDISTRIBUTION AND TEXTURAL CHANGES IN THE BRAIN TISSUE UPON THE STATIC MAGNETIC FIELD EXPOSURE

Ilić AŽ, de Luka SR, Popović TB, Debeljak-Martačić J, Kojadinović M, Ćirković S, Ristić-Djurović JL, Trbovich AM. Distinct fatty acid redistribution and textural changes in the brain tissue upon the static magnetic field exposure. Environ Toxicol Pharmacol. 2022 Mar 19:103853. doi: 10.1016/j.etap.2022.103853.

Highlights

- Biochemical and imaging analysis of static magnetic field induced tissue changes.
- Brain fatty acid redistribution explained and linked to the pathohistology level.
- Cross-comparison of fractal, multifractal, gray level co-occurrence matrix analysis.
- Subtle initial structural changes observed by the digital imaging analysis (DIA).
- Combined biochemical / DIA analysis promising in the study of mild tissue changes.

Abstract

We observed different outcomes upon the subacute exposure to the 128 mT highly homogeneous static magnetic field (SMF) when its orientation was (i) aligned with the vertical component of the geomagnetic field; (ii) in the opposite direction. We employed the fatty acids (FA) composition and digital image analyses (DIA) to provide insights into the underlying processes and examine the possible weak SMF effects. Swiss-Webster male mice were whole-body exposed for 1h/day over five days. Brain tissue's thin liquid chromatography resulted in brain FA composition, indicating a possible sequence of changes due to the SMF exposure. Quantitative DIA accurately assessed different image parameters. Delicate textural changes were revealed in the group where pathohistological or biochemical alterations have not been detected. DIA-based biological markers seem to be very promising for studying delicate tissue changes, which results from the high sensitivity and wide availability of DIA. We observed different outcomes upon the subacute exposure to the 128 mT highly homogeneous static magnetic field (SMF) when its orientation was (i) aligned with the vertical component of the geomagnetic field; (ii) in the opposite direction. We employed the fatty acids (FA) composition and digital image analyses (DIA) to provide insights into the underlying processes and examine the possible weak SMF effects. Swiss-Webster male mice were whole-body exposed for 1h/day over five days. Brain tissue's thin liquid chromatography resulted in brain FA composition, indicating a possible sequence of changes due to the SMF exposure. Quantitative DIA accurately assessed different image parameters. Delicate textural changes were revealed in the group where pathohistological or biochemical alterations have not been detected. DIA-based biological markers seem to be very promising for studying delicate tissue changes, which results from the high sensitivity and wide availability of DIA.
https://pubmed.ncbi.nlm.nih.gov/35318121/

IMPACTS OF SMARTPHONE RADIATION ON PREGNANCY: A SYSTEMATIC REVIEW

Imteyaz El Jarrah, Mohammad Rababa. Impacts of smartphone radiation on pregnancy: A systematic review. Helyion. 2022 Feb;8(2):e08915. doi: 10.1016/j.heliyon.2022.e08915.

Abstract

Introduction: The COVID-19 pandemic has impacted all aspects of people's lives, with many tasks and services now being delivered online in the aim of reducing contact and preventing further transmission of the disease. This has resulted in the increase in the use of portable electronic devices (i.e., mobile phones, smartphones, laptops), which emit different frequencies of electromagnetic field (EMF) radiation. However, the evidence on the harmful impacts of EMF radiation exposure on the human body, particularly on the abdomen of the female body during pregnancy, is scarce. Further, the related studies in the literature have yet to be systematically reviewed. If unmanaged, the absorption of EMF radiation by the maternal abdomen during pregnancy is associated with serious birth and infant outcomes.

Purpose: This study aimed to systematically review the published studies on the direct effects of EMF radiation emitted from mobile phones on pregnancy, birth, and infant outcomes.

Methods: After a systematic search using the PRISMA guidelines, a total of 18 articles were retrieved from 5 databases. Studies which addressed the negative outcomes of EMF radiation exposure on mothers, adults, and children's health were included. The research articles were then sorted based on whether their findings were related to the impacts of EMF on physiological or pregnancy outcomes.

Results: The findings of this review showed that EMF radiation exposure is associated with hormonal, thermal, and cardiovascular changes among adults. However, the reviewed studies did not consider the impacts of EMF radiation exposure on pregnancy outcomes specifically, which makes it difficult to draw conclusions from this review. Only four of the reviewed studies were conducted among pregnant women. These studies reported that EMF radiation exposure during pregnancy is associated with miscarriages and fluctuations in the fetal temperature and heart rate variability, as well as infant anthropometric measures.

Conclusions: More research should be conducted to identify the specific impacts of EMF radiation exposure on pregnancy, birth, and infant outcomes. Healthcare providers and researchers are recommended to collaborate to improve public health through public education and updated organizational policies to limit these environmental risks by encouraging the use of safe technologies.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8823972/

THE ROLE OF NON-IONIZING ELECTROMAGNETIC RADIATION ON FEMALE FERTILITY: A REVIEW

Pooja Jangid, Umesh Rai, Radhey Shyam Sharma, Rajeev Singh. The role of non-ionizing electromagnetic radiation on female fertility: A review. Int J Environ Health Res. 2022 Feb 8;1-16. doi: 10.1080/09603123.2022.2030676.

Abstract

With increasing technological developments, exposure to non-ionizing radiation has become unavoidable as people cannot escape from electromagnetic field sources, such as Wi-Fi, electric wires, microwave oven, radio, telecommunication, bluetooth devices, etc. These radiations can be associated with increased health problems of the users. This review aims to determine the effects of non-ionizing electromagnetic radiations on female fertility. To date, several in vitro and in vivo studies unveiled that exposure to non-ionizing radiations brings about harmful effects on oocytes, ovarian follicles, endometrial tissue, estrous cycle, reproductive endocrine hormones, developing embryo, and fetal development in animal models. Non-ionizing radiation also upsurges the free radical load in the uterus and ovary, which leads to inhibition of cell growth and DNA disruptions. In conclusion, non-ionizing electromagnetic radiation can cause alterations in both germ cells as well as in their nourishing environment and also affect other female reproductive parameters that might lead to infertility. https://pubmed.ncbi.nlm.nih.gov/35132884/

THREE QUARTERS OF A CENTURY OF RESEARCH ON RF EXPOSURE ASSESSMENT AND DOSIMETRY—WHAT HAVE WE LEARNED? (REVIEW)

Kenneth R. Foster, Marvin C. Ziskin, Quirino Balzano. 2022. Three Quarters of a Century of Research on RF Exposure Assessment and Dosimetry—What Have We Learned? International Journal of Environmental Research and Public Health 19, no. 4: 2067. doi: 10.3390/ijerph19042067. (This article belongs to the Special Issue Occupational and General Public Exposure to Electromagnetic Fields).

Abstract

This commentary, by three authors with an aggregate experience of more than a century in technology and health and safety studies concerning radiofrequency (RF) energy, asks what has been learned over the past 75 years of research on radiofrequency and health, focusing on technologies for exposure assessment and dosimetry. Research programs on health and safety of RF exposure began in the 1950s, initially motivated by occupational health concerns for military personnel, and later to address public concerns about exposures to RF energy from environmental sources and near-field exposures from RF transmitting devices such as mobile phones that are used near the body. While this research largely focused on the biological effects of RF energy, it also led to important improvements in exposure assessment and dosimetry. This work in the aggregate has made RF energy one of the best studied potential technological hazards and represents a productive response by large numbers of scientists and engineers, working in many countries and supported by diverse funding agencies, to the ever rapidly evolving uses of the electromagnetic spectrum. This review comments on present needs of the field, which include raising the quality of dosimetry in many RF bioeffects studies and developing improved exposure/dosimetric techniques for the higher microwave frequencies to be used by forthcoming communications technologies. At

present, however, the major uncertainties in dosimetric modeling/exposure assessment are likely to be related to the inherent variability in real-world exposures, rather than imprecision in measurement technologies.

Conclusions

In summary, seven decades of research on dosimetry/exposure assessment have led to the development of technologies that permit very detailed and accurate evaluation of RF exposure to the human body, both in the near field of devices such as mobile phones, and in the far field from environmental sources. However, accurate exposure assessment and dosimetry can require expensive equipment and specialized engineering support and is not always achieved in bioeffects studies. Progress on dosimetry/exposure assessment is continuing at the higher microwave frequencies that used by 5G NR systems and other mm-wave communications systems. Based on the previous success of this endeavor, we can expect that the tools to assess the exposure of biological systems to mm-wave radiation from 5G NR and other applications of this part of the RF spectrum will, in time, reach the level of sophistication and accuracy that is currently achieved for RF signals at lower frequencies.

Open access paper: https://www.mdpi.com/1660-4601/19/4/2067/htm

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ELECTROMAGNETIC HYPERSENSITIVITY CLOSE TO MOBILE PHONE BASE STATIONS – A CASE STUDY IN STOCKHOLM, SWEDEN

Lennart Hardell, Tarmo Koppel. Electromagnetic hypersensitivity close to mobile phone base stations – a case study in Stockholm, Sweden. Reviews on Environmental Health. Mar 2, 2022. doi: 10.1515/reveh-2021-0169.

Abstract

A previously healthy worker developed symptoms assigned to electromagnetic hypersensitivity (EHS) after moving to an office with exposure to high levels of anthropogenic electromagnetic fields (EMFs). These symptoms consisted of e.g. headache, arthralgia, tinnitus, dizziness, memory loss, fatique, insomnia, transitory cardiovascular abnormalities, and skin lesions. Most of the symptoms were alleviated after 2 weeks sick leave. The highest radiofrequency (RF) field level at the working place was 1.72 V/m (7,852 μW/m2). Maximum value for extremely low frequency electromagnetic field (ELF-EMF) from electric power at 50 Hz was measured to 285 nT (mean 241 nT). For electric train ELF-EMF at 16.7 Hz was measured to 383 nT (mean 76 nT). Exposure to EMFs at the working place could be the cause for developing EHS related symptoms. The association was strengthened by the symptom reduction outside the working place.

Conclusions

1) This investigation established three possible reasons for developing health symptoms associated with the EMF exposure, including the following.
2) The working room was right below the mobile phone base station antenna, located on the roof of the building. The close proximity to these antennas caused significantly high RF radiation exposure in the working area.
3) The working room is also positioned close to lower radiofrequency transmitter (TETRA emergency services), located on the neighboring roof of the same building.

The working room was positioned within 20 m from the electric train railroad. 16 Hz magnetic field from the railroad power cable was on some instances the highest ELF MF component in the room, exceeding even the power grid 50 Hz MFs. Also, railroad power cable induced a fluctuating magnetic field in the office due to the coming and passing electric trains. As trains come and go, this introduces a change in the electric power supplied by the railroad electric cable. Consequently the magnetic field also changes in great amplitude.

In conclusion, there are at least three types of electromagnetic fields present in the working room, which cause a long term exposure to the workers. Exposure to multiple source electromagnetic fields could be the cause for developing EHS related symptoms. However, the person had been exposed to ELF-EMF also at other locations in the building, so exposure to RF-EMF seems to be the most probable cause to her developed health problems.

Open access paper: https://www.degruyter.com/document/doi/10.1515/reveh-2021-0169/html

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ASSESSMENT OF HUMAN EXPOSURE LEVELS DUE TO MOBILE PHONE ANTENNAS IN 5G NETWORKS

Marta Bonato, Laura Dossi, Silvia Gallucci, Martina Benini, Gabriella Tognola, Marta Parazzini. Assessment of Human Exposure Levels Due to Mobile Phone Antennas in 5G Networks. Int J Environ Res Public Health. 2022 Jan 29;19(3):1546. doi: 10.3390/ijerph19031546. (This article belongs to the Special Issue EMF Exposure Assessment in 5G and 6G Emerging Scenarios in Humans and Environment)

Abstract

The recent deployment of 5G networks is bringing benefits to the population but it is also raising public concern about human RF-EMF exposure levels. This is particularly relevant considering the next 5G mobile devices, which are placed in close proximity to the subjects. Therefore, the aim of the following paper is focused on expanding the knowledge of the exposure levels in 5G exposure scenarios, specifically for mobile applications, using computational methods. The mobile antenna was designed considering the 5G technology innovations (i.e., mm- wave spectrum, beamforming capability, high gain and wide coverage), resulting in a phased-array antenna with eight elements at the working frequency of 27 GHz. To assess the exposure levels, different types of skin models with different grades of details and layers were considered. Furthermore, not only was the presence of a mobile phone user simulated, but also that of a person in their proximity, who could be hit by the main beam of the phased-array antenna. All the simulations were conducted in Sim4Life platform, where the exposure levels were assessed in terms of absorbed power density averaged over 4 cm2 and 1 cm2, following the ICNIRP guidelines.

The results highlighted that the use of the homogeneous skin model led to the absorbed power density peaks being greatly underestimated, with respect to those obtained in multilayer skin models. Furthermore, interestingly, we found that the exposure levels obtained for the person passing nearby were slightly higher

than those experienced by the mobile phone user himself. Finally, using the allowed input power for real mobile applications, all the values remained below the limits indicated by the ICNIRP guidelines.

Conclusions

In conclusion, the aim of further expanding the knowledge about 5G mm-wave exposure in mobile applications was achieved. The results confirmed that at these high frequencies it is essential to consider a multilayer model of the skin rather than a simple homogeneous one that could lead to greatly underestimating the exposure levels. Furthermore, the study highlights those efforts should be focused not only on evaluating the exposure levels for the mobile phone users but also for people passing nearby, who could be hit by the main lobe of the mobile antenna pattern. Finally, it is important to underline that the maximum values of Sab obtained in all the conducted simulations, when scaled for a real input power (23 dBm, i.e., 200 mW) respect the basic restrictions indicated in the ICNIRP guidelines to avoid harmful effects. Future work will deal with the investigation of detailed skin tissues to be used in anatomical models, to take into account the real morphology of human subjects, and the study of the impact of the beamforming capability of the mobile antenna on the exposure scenario. Open access paper: https://www.mdpi.com/1660-4601/19/3/1546

Radiofrequency Electromagnetic Field Exposure and Apoptosis: A Scoping Review of In Vitro Studies on Mammalian Cells

Romeo S, Zeni O, Scarfì MR, Poeta L, Lioi MB, Sannino A. Radiofrequency Electromagnetic Field Exposure and Apoptosis: A Scoping Review of In Vitro Studies on Mammalian Cells. Int J Mol Sci. 2022;23(4):2322. 2022 Feb 19. doi:10.3390/ijms23042322

Abstract

In the last decades, experimental studies have been carried out to investigate the effects of radiofrequency (RF, 100 kHz–300 GHz) electromagnetic fields (EMF) exposure on the apoptotic process. As evidence-based critical evaluation of RF and apoptosis in vitro is lacking, we performed a scoping literature review with the aim of systematically mapping the research performed in this area and identifying gaps in knowledge. Eligible for inclusion were in vitro studies assessing apoptosis in mammalian cells exposed to RF-EMF, which met basic quality criteria (sham control, at least three independent experiments, appropriate dosimetry analysis and temperature monitoring). We conducted a systematic literature review and charted data in order to overview the main characteristics of included studies. From the 4362 papers retrieved with our search strategy, 121 were pertinent but, among them, only 42 met basic quality criteria. We pooled data with respect to exposure (frequency, exposure level and duration) and biological parameters (cell type, endpoint), and highlighted some qualitative trends with respect to the detection of significant effect of RF-EMF on the apoptotic process. We provided a qualitative picture of the evidence accumulated so far, and highlighted that the quality of experimental methodology still needs to be highly improved.

Excerpt

We have overviewed the main characteristics and outcome of the included studies. The majority of them did not find significant alterations of the apoptotic process due to RF-EMF exposure. Looking at the experiments extracted from the studies, when a statistically significant effect was observed it mainly occurred at frequencies above 6 GHz, and for acute

(≤ 1h) exposure durations. However, since the number of studies reporting effects is very small, and the considered experimental conditions are highly heterogeneous, further investigations are needed, together with replication studies, to confirm or confute these results. Moreover, even though the included studies met the basic quality criteria, most of them still presented flaws in the experimental methods (lack of blind analysis and/or positive control, assessment of single endpoints). It can be stated that, to be of value, future studies that investigate the effect of RF-EMF in mammalian cells should aim to be of high methodological quality and be sufficiently powered by performing an adequate number of experiments.

Conclusions
This scoping review sought to systematically map the research regarding the effects of RF-EMF on apoptosis in mammalian cells, and to identify any existing gaps in knowledge within health risk assessment of RF-EMF exposures. This will definitely facilitate to gain reliable information on the effects of RF exposure on the apoptotic process when in a next step, a quantitative analysis of the papers included in this scoping review will be carried out by mainly addressing questions on the direction of the effect (induction or suppression of apoptosis), effect size, possible dose–response relationship, possible association of the effect size with the quality score of the experiments, and possible major capability of certain exposure parameter ranges to exert an effect. The major gap in knowledge from the qualitative analysis conducted here is the lack of a systematic approach based on quality of the experimental methodologies adopted in the studies retrieved and analyzed in this scoping review.

Therefore, the evidence here presented is a further confirmation that, in spite of the large amount of relevant papers available in the literature, a huge effort still needs to be made in bioelectromagnetic research towards the improvement of experimental quality, which is crucial to guarantee the reliability, robustness and reproducibility of results.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8877695/

PROTOCOL FOR A SYSTEMATIC REVIEW OF THE IN VIVO STUDIES ON RADIOFREQUENCY (100 KHZ-300 GHZ) ELECTROMAGNETIC FIELD EXPOSURE AND CANCER

Pinto R, Ardoino L, Giardullo P, Villani P, Marino C. Protocol for a systematic review of the in vivo studies on radiofrequency (100 kHz-300 GHz) electromagnetic field exposure and cancer. Syst Rev. 2022 Feb 16;11(1):29. doi: 10.1186/s13643-022-01898-4.

Abstract

Background: An Italian project aims to review the scientific literature on the possible carcinogenicity of radiofrequency (100 kHz-300 GHz) electromagnetic field (RF-EMF) exposure. The ENEA team has to carry out a systematic review of the in vivo studies on this topic.

Objectives: Development of a protocol for a systematic review (meta-analysis included) to investigate the potential carcinogenic risk following RF-EMF in vivo exposure to doses above or within legal limits. The aims of this review are (1) to provide a descriptive and, if possible, a quantitative summary of the results of the examined RF-EMF in vivo studies, together with

an assessment of the consistency of observations and of the causes of heterogeneity, and (2) to assess the weight of evidence to support or refute the hypothesis of carcinogenic effects caused by RF-EMF exposure and to draw conclusions about the potential for carcinogenicity of RF-EMF exposure.

Methods: We will search for relevant studies in electronic academic databases and in the reference list of selected papers and reviews on the topic, including the descriptive reviews on RF-EMF carcinogenic effect carried out by international panels of experts since 2011. The following elements of the PECO question were defined: experimental studies on rodents of both sexes, all ages and species, all genetic backgrounds (Population) exposed to RF-EMF alone, or in combination with other physical or chemical agents (Exposure); only studies reporting outcome data in exposed and sham control groups (Comparison); and all types of cancer with all tumor-related outcome measures (Outcome) will be included. Only peer-reviewed articles written in English will be considered without limit in the publication date. Eligibility criteria were defined for papers to be included. A risk of bias assessment will be performed using a tool specifically developed for animal studies. A meta-analysis will be performed, if feasible, for all outcome measures; for subgroup analysis, a minimum of 3 studies per subgroup will be required. If meta-analysis will not be possible, a narrative synthesis of the results will be reported.

Systematic review registration: PROSPERO CRD42020191105 HIGHLIGHTS: An Italian collaborative research agreement aims to review the scientific literature on the possible carcinogenicity of RF-EMF (100 kHz - 300 GHz). The ENEA team will systematically review and, if possible, meta-analyse estimates the effects of in vivo exposure to RF-EMF exposure on cancer. The ENEA group is a multidisciplinary team of researchers with a consolidated experience both in carcinogenicity experiments and radiofrequency dosimetric assessment. The proposed protocol uses the NTP OHAT Approach for Systematic Review as an organizing framework. The proposed protocol aims to lead to the first systematic review providing a strength of evidence assessment on this topic. https://pubmed.ncbi.nlm.nih.gov/35172887/

Monte Carlo Simulation of Clothed Skin Exposure to Electromagnetic Field With Oblique Incidence Angles at 60 GHz

Li Kun, Sasaki Kensuke. Monte Carlo Simulation of Clothed Skin Exposure to Electromagnetic Field With Oblique Incidence Angles at 60 GHz. Frontiers in Public Health. Vol. 10. 2022. doi: 10.3389/fpubh.2022.795414.

Abstract

This study presents an investigation of clothed human skin exposure to obliquely incident electromagnetic waves at 60 GHz. We clarified the combined impacts of the cloth material, incidence angle, and polarization on the assessment of transmittance and absorbed power density (APD) at the skin surface. A Monte Carlo simulation was conducted considering the thickness variation of the cloth material and skin tissue. For the case of transverse magnetic™ wave exposure, the transmittance increases with increasing incident angle up to the maximum transmittance angle in the range from 60 to 80°, which is known as the Brewster effects, regardless of textile materials and air gap between cloth and skin. The air gap results in a periodic fluctuation of the APD, where the variation is almost within 1 dB when the incident power density is constant and the incident angle is smaller than 40°. Our results also

show that as the air gap increases to 2.5 mm, i.e., half-wavelength at 60 GHz in the air, the APD within the skin surface covered by typical cloth materials increases up to 40% compared with that of bare skin. Although the use of several cloth materials may increase the transmittance and APD in oblique incidence scenarios, all the results of the APD do not exceed the basic restriction for local exposure, demonstrating that the current guidelines for human exposure to electromagnetic fields are appropriate for preventing the excessive exposure at 60 GHz considering the impacts of oblique incidence angles and cloth materials.
Open access paper: https://www.frontiersin.org/article/10.3389/fpubh.2022.795414

EXPOSURE TO 1.8 GHZ RADIOFREQUENCY FIELD MODULATES ROS IN HUMAN HEK293 CELLS AS A FUNCTION OF SIGNAL AMPLITUDE

Marootpong Pooam, Nathalie Jourdan, Blanche Aguida, Cyril Dahon, Soria Baouz, Colin Terry, Haider Raad, Margaret Ahmad. Exposure to 1.8 GHz radiofrequency field modulates ROS in human HEK293 cells as a function of signal amplitude. Commun Integr Biol. 2022 Feb 3;15(1):54-66. doi: 10.1080/19420889.2022.2027698.

Abstract

The modern telecommunications industry is ubiquitous throughout the world, with a significant percentage of the population using cellular phones on a daily basis. The possible physiological consequences of wireless emissions in the GHz range are therefore of major interest, but remain poorly understood. Here, we show that exposure to a 1.8 GHz carrier frequency in the amplitude range of household telecommunications induces the formation of ROS (Reactive Oxygen Species) in human HEK293 cultured cells. The ROS concentrations detected by fluorescent imaging techniques increased significantly after 15 minutes of RF field exposure, and were localized to both nuclear and cytosolic cellular compartments. qPCR analysis showed altered gene expression of both anti-oxidative (SOD, GPX, GPX, and CAT) and oxidative (Nox-2) enzymes. In addition, multiple genes previously identified as responsive to static magnetic fields were found to also be regulated by RF, suggesting common features in response mechanisms. By contrast, many RF effects showed evidence of hormesis, whereby biological responsivity does not occur linearly as a function of signal amplitude. Instead, biphasic dose response curves occur with 'blind' spots at certain signal amplitudes where no measureable response occurs. We conclude that modulation of intracellular ROS can be a direct consequence of RF exposure dependent on signal frequency and amplitude. Since changes in intracellular ROS may have both harmful and beneficial effects, these could provide the basis for many reported physiological effects of RF exposure.
https://pubmed.ncbi.nlm.nih.gov/35126804/

MOLECULAR MECHANISM OF MALIGNANT TRANSFORMATION OF BALB/C-3T3 CELLS INDUCED BY LONG-TERM EXPOSURE TO 1800 MHZ RADIOFREQUENCY ELECTROMAGNETIC RADIATION (RF-EMR)

Zhen Ding, Xiaoyong Xiang, Jintao Li, Shuicai Wu. Molecular Mechanism of Malignant Transformation of Balb/c- 3T3 Cells Induced by Long-Term Exposure to 1800 MHz Radiofrequency Electromagnetic Radiation (RF-EMR). Bioengineering (Basel). 2022 Jan 18;9(2):43. doi: 10.3390/bioengineering9020043.

Abstract

Purpose: We aimed to investigate RF-EMR-induced cell malignant transformation.

Methods: We divided Balb/c-3T3 cells into sham and expo groups. The expo groups were exposed to a 1800 MHz RF continuous wave for 40 and 60 days, for 4 h per day. The sham group was sham-exposed. Cells were harvested for a cell transformation assay, transplantation in severe combined immune deficient (SCID) mice, soft agar clone formation detection, and a transwell assay. The mRNA microarray assay was used to declare key genes and pathways.

Results: The exposed Balb/c-3T3 cells showed a strong increase in cell proliferation and migration. Malignant transformation was observed in expo Balb/c-3T3 cells exposed for 40 days and 60 days, which was symbolized with visible foci and clone formation. Expo Balb/c-3T3 cells that were exposed for 40 days and 60 days produced visible tumors in the SCID mice. Lipid metabolism was the key biological process and pathway involved. The mevalonate (MVA) pathway was the key metabolic pathway. The interacted miRNAs could be further research targets to examine the molecular mechanism of the carcinogenic effects of long-term exposure.

Conclusion: Exposure for 40 and 60 days to 1800 MHz RF-EMR induced malignant transformation in Balb/c-3T3 cells at the SAR of 8.0 W/kg. We declared that lipid metabolism was the pivotal biological process and pathway. The MVA pathway was the key metabolic pathway. Open access paper: https://www.mdpi.com/2306-5354/9/2/43

ATTRIBUTES OF NON-IONIZING RADIATION OF 1800 MHZ FREQUENCY ON PLANT HEALTH AND ANTIOXIDANT CONTENT OF TOMATO (SOLANUM LYCOPERSICUM) PLANTS

Chandni Upadhyaya, Trushit Upadhyaya, Ishita Patel. Attributes of non-ionizing radiation of 1800 MHz frequency on plant health and antioxidant content of Tomato (Solanum Lycopersicum) plants. Journal of Radiation Research and Applied Sciences. 15(1):54-68. 2022. doi: 10.1016/j.jrras.2022.02.001.

Abstract

The Globe is marching towards the development of the telecommunication field which leads to increment of non-ionizing radiation in the environment which affects all living beings including plants grown nearby to communication base stations. The present research was focused on physiological and biochemical alterations of tomato plants exposed to high-frequency radiation. The overall plant health was analyzed by physiological changes viz., plant height, size of leaves, length to the root system, and rate of germination upon exposure of radiation and shown significant reduction ($p < 0.05$) compared to control. Consecutively,

radiation also negatively affects the photosynthetic pigment content of leaves which has shown significant reduction. Yet another confirmation of stress on exposed plant tissue was reported by obtaining higher H2O2 content within exposed plant leaf than the control. The morphological alterations viz. curling of leaves, discoloration, and size reduction became more prominent with an increase in the exposure time. The significant outcomes denoted according to 95% confidence limit. There was a significant decline in total phenolic content (37.06%), flavonoid content (71.38%), Vitamin C content (72.45%), and DPPH (59.32%) as well as total antioxidant assays (71.89%) which revealed significant deteriorative effects on such waves on secondary metabolites and the antioxidant potential of tomato plants. The lycopene content was continuously increasing up to 73.13% upon radiation of 120 h and such raise was the direct indication of harmful effect on fruit skin and release of lycopene due to softening of the fruit tissue. Thus, the presented findings illustrated the negative effects of such waves on the quality of tomato plants. The limited insight of metabolic pathways involved in plant responses to such non- ionizing radiation makes such investigation worth in agricultural application. Additionally, mobile communication agencies should be informed and installation of base stations for mobile communication towers should be prohibited at agricultural lands.

Excerpts

The ambient field in the greenhouse was as low as 1.1–1.5 V/m.... With an exposure of continuous wave (CW) electromagnetic field of 8 V/m, the SAR value was found to be 3.16 × 10−2 W kg−1 and 0.15 W kg−1 for leaves and fruits samples respectively....

Conclusion

The presented investigation discovered that all measured physiological parameters revealed deterioration with increase in electromagnetic exposure. However, the transient improvement in rate of seed germination and plant growth parameters can be considered as positive effect of short-term (12–24 h) exposure. The prolonged exposure effect on antioxidant content and activity interpreted the harmful effects of such radiation. Although, exposure of 12–24 h gave positive results for phenolic and flavonoid content assays and in the range of 1–10% for both fruit and leaf samples and indicated stimulation of plant defense system. The most significant outcomes in terms of deterioration were observed in the assays from fruit tissues viz. 36.97, 71.38, 72.45% decline in phenolic compounds, flavonoids, vitamin C content respectively. The throughout increase of lycopene in fruits (73.13%) indicated softening of skin and release of lycopene. There was a brief increase in enzymatic antioxidants POD and PPO activity upon 24–48 h of exposure which was followed by a constant decline with an increase in exposure time and revealed weakening of the defense system and plant health. The quality of exposed tomato fruits also deteriorated upon prolonged exposure. As there is constant advancement in electronics and communication and our march towards 5G frequency, the consequences of exposure to such radiation on plants should be investigated thoroughly. https://www.sciencedirect.com/science/article/pii/S168785072200125X

HEALTHY DISORDERS BY WLAN-EXPOSURE

von Klitzing L. Healthy disorders by WLAN-exposure.J Clin Images Med Case Rep 2022; 3 (2): 1-3. doi:10.52768/2766-7820/1639

Abstract

By a diagnostic routine of a “burn-out”-patient, additionally claiming an electrosensitivity, there was tested the activity of the autonomic nervous system by electromyogram (EMG). Analyzing the frequency we found an artificial 10 Hz-component like those of WLAN-emitters as a dominant signal. By the following anamnestic discussion, the patient told about a longtime exposure to an active WLAN-equipment in office. Testing other patients using this communication-technique, there was a great number with the same 10 Hz-artifact in EMG. Additionally, some of these patients point out an artificial ECG. These data demonstrate the conflicts with the ICNIRP safety guidelines for this type of electromagnetic exposures.

Open access paper: http://www.jcimcr.org/pdfs/JCIMCR-v3-1639.pdf

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SIMULTANEOUS EFFECT OF GAMMA AND WI-FI RADIATION ON GAMMA-H2AX EXPRESSION IN PERIPHERAL BLOOD OF RAT: A RADIO-PROTECTION NOTE

Ehsan Khodamoradi, Shima Afrashi, Karim Khoshgard, Farshid Fathi, Soodeh Shahasavari, Rasool Azmoonfar, Masoud Najafi.. Biochemistry and Biophysics Reports. Volume 30, 2022. doi: 10.1016/j.bbrep.2022.101232.

Abstract

Introduction Nuclear medicine patients are isolated in a room after the injection of a radiopharmaceutical. They may be active Wi-Fi option of its smartphone mobile or other environmental radiofrequency waves. The hypothesis of this study was the evaluation of increased biological effects of the simultaneous exposure to gamma-ray and the Wi-Fi waves by measuring the level of the increased double strand-breaks DNA in peripheral blood lymphocyte in the rat.

Materials and methods Fifty male Wistar rats were exposed for 2, 24, and 72 h only by Wi-Fi, 99m Tc, and simultaneously by Wi-Fi and 99m Tc. The power density levels of Wi-Fi emitter at 15 cm was 4.2nW/ cm2. An activity of 100 µCi of 99m Tc was injected intraperitoneally. Blood samples were taken by cardiac puncture following general anesthesia. Mononuclear cells are extraction by Ficoll-Hypaque density gradient centrifugation. The number of gamma-H2AX foci per nucleus was counted by flow cytometry. The statistical differences between experimental groups at 2, 24, and 72 h were determined with a repeated measure's analysis of variance. The significant difference between groups at the same time was analyzed with the Kruskal- Wallis Test.

Results The manner of gamma-H2AX expression was not the same for three groups in time. The number of gamma-H2AX foci between the three groups was a significant difference after 72 h.

Conclusion Simultaneous Wi-Fi and gamma-ray exposures can increase the number of double-strand break DNA in peripheral blood lymphocytes to exposure of gamma-ray to 72 h after technetium injection in the rat.

Open access paper: https://www.sciencedirect.com/science/article/pii/S2405580822000334

ASSOCIATIONS BETWEEN A POLYMORPHISM IN THE RAT 5-HT1A RECEPTOR GENE PROMOTER REGION (RS198585630) AND COGNITIVE ALTERATIONS INDUCED BY MICROWAVE EXPOSURE

Li Haijuan, Gao Yu, Zou Yong, Qiao Simo, Zhi Weijia, Ma Lizhen, Xu Xinping, Zhao Xuelong, Zhang Junhua, Wang Lifeng, Hu Xiangjun. Associations Between a Polymorphism in the Rat 5-HT1A Receptor Gene Promoter Region (rs198585630) and Cognitive Alterations Induced by Microwave Exposure. Frontiers in Public Health. 10. 2022. doi: 10.3389/fpubh.2022.802386.

Abstract

The nervous system is a sensitive target of electromagnetic radiation (EMR). Chronic microwave exposure can induce cognitive deficits, and 5-HT system is involved in this effect. Genetic polymorphisms lead to individual differences. In this study, we evaluated whether the single-nucleotide polymorphism (SNP) rs198585630 of 5- HT_{1A} receptor is associated with cognitive alterations in rats after microwave exposure with a frequency of 2.856 GHz and an average power density of 30 mW/cm². Rats were exposed to microwaves for 6 min three times a week for up to 6 weeks. PC12 cells and 293T cells were exposed to microwaves for 5 min up to 3 times at 2 intervals of 5 min. Transcriptional activity of 5-HT_{1A} receptor promoter containing rs198585630 C/T allele was determined in vitro. Electroencephalograms (EEGs), spatial learning and memory, and mRNA and protein expression of 5-HT_{1A} receptor were evaluated in vivo. We demonstrated that transcriptional activity of 5-HT_{1A} receptor promoter containing rs198585630 C allele was higher than that of 5-HT_{1A} receptor promoter containing T allele. The transcriptional activity of 5-HT_{1A} receptor promoter was stimulated by 30 mW/cm² microwave exposure, and rs198585630 C allele was more sensitive to microwave exposure, as it showed stronger transcriptional activation. Rats carrying rs198585630 C allele exhibited increased mRNA and protein expression of 5-HT_{1A} receptor and were more susceptible to 30 mW/cm² microwave exposure, showing cognitive deficits and inhibition of brain electrical activity. These findings suggest SNP rs198585630 of the 5-HT_{1A} receptor is an important target for further research exploring the mechanisms of hypersensitivity to microwave exposure.

Open access paper: https://www.frontiersin.org/article/10.3389/fpubh.2022.802386

CORNEAL OPACITY IN NORTHERN BALD IBISES (GERONTICUS EREMITA) EQUIPPED WITH RADIO TRANSMITTERS

Alfonso Balmori. Corneal opacity in Northern Bald Ibises (Geronticus eremita) equipped with radio transmitters. Electromagnetic Biology and Medicine. 2022 Feb 27;1-3. doi: 10.1080/15368378.2022.2046046.

Abstract

This note is intended to try to shed light on the discoveries made entitled "Biologging is suspect to cause corneal opacity in two populations of wild living Northern Bald Ibises (Geronticus eremita)". In this article, researchers participating in a reintroduction program for this endangered species in Europe document the unilateral corneal opacity that took place after birds were equipped with solar radio transmitters fixed on their upper-back position. The authors propose several possible effects caused by the device to explain the problem,

and they conclude that the most parsimonious explanation for the symptomatology is a repetitive slight temperature rise in the corneal tissue due to electromagnetic radiation by the Global System for Mobile Communications (GSM) module of the device. The proposal of this communication is that these effects do not necessarily have to be thermal, but they can be non-thermal and thus more subtle and insidious. These effects may be caused by electromagnetic radiation at low levels but in long-term exposure. https://pubmed.ncbi.nlm.nih.gov/35220839/

ENDOGENOUS CA 2+ RELEASE WAS INVOLVED IN 50-HZ MF-INDUCED PROLIFERATION VIA AKT-SK1 SIGNAL CASCADE IN HUMAN AMNIOTIC EPITHELIAL CELLS

An-Fang Ye, Xiao-Chen Liu, Liang-Jing Chen, Yong-Peng Xia, Xiao-Bo Yang, Wen-Jun Sun. Endogenous Ca 2+ release was involved in 50-Hz MF-induced proliferation via Akt-SK1 signal cascade in human amniotic epithelial cells. Electromagn Biol Med. 2022 Feb 7;1-10. doi: 10.1080/15368378.2022.2031211.

Abstract

The mechanism underlying the biological effects caused by an extremely low-frequency electromagnetic field (ELF-EMF) is still unclear. Previously, we found that L-type calcium channel and sphingosine kinase 1 (SK1) were involved in 50-Hz MF exposure-induced cell proliferation. In the present study, the role of intracellular Ca2+ and signal molecules related to SK1 in cell proliferation induced by 50-Hz MF was investigated in human amniotic epithelial (FL) cells. Results showed that the intracellular Ca2+ chelator, BAPTA, could completely inhibit 50-Hz MF-induced cell proliferation, whereas NIF, the inhibitor of L-type calcium channel, only partly blocked it. When cells were cultured in calcium-free medium, MF exposure also increased intracellular Ca2+, activated SK1 and promoted cell proliferation although all of those increasing levels were lower than those in complete medium. Moreover, MF-activated SK1 could be completely inhibited by BAPTA, and MF-induced cell proliferation was abolished by SKI II, the specific inhibitor of SK1. Additionally, a 50-Hz MF exposure did not affect the activation of ERK and PKCα under the condition of calcium-free medium, but activated the Akt, which could be precluded entirely by BAPTA, but not be inhibited by NIF. Treatment of FL cells with LY294002, the inhibitor of Akt, could delete the MF-induced SK1 activation under the condition of calcium-free medium. Based on the data from the present experiment, it is concluded that endogenous Ca2+ release was involved in 50-Hz MF-induced cell proliferation via Akt-SK1 signal cascade. https://pubmed.ncbi.nlm.nih.gov/35129008/

DETECTION OF THE CHEMICAL CHANGES IN BLOOD, LIVER, AND BRAIN CAUSED BY ELECTROMAGNETIC FIELD EXPOSURE USING RAMAN SPECTROSCOPY, BIOCHEMICAL ASSAYS COMBINED WITH MULTIVARIATE ANALYSES

Zozan Guleken, Monika Kula-Maximenko, Joanna Depciuch, Alp Mahmut Kılıç, Devrim Sarıbal. Photodiagnosis Photodyn Ther. 2022 Feb 18;102779. doi: 10.1016/j.pdpdt.2022.102779.

Abstract

The effects of the electromagnetic field on living organisms have been studied for several years. In this article, we showed what kind of cold change an extremely low-frequency electromagnetic field (ELF-MF) exposure 500 µT 50 Hz by using a Meritt Coil System causes in the samples of the brain and liver samples. To measure oxidative load, we measured malondialdehyde (MDA) and glutathione (GSH) levels. To identify the chemical changes, we

collected Raman spectra of cerebellum, left brain, right brain and liver tissue from the control group of animals and from the animal, which were exposed to an electromagnetic field (ELF-MF group).

Obtained results showed that lipid peroxidation was increased and the antioxidant response was decreased. In the brain samples the shift of peaks corresponding to the amide III vibrations existed after ELF-MF exposure.

Structural changes were detected in CH2 vibrations originating from lipids in both hemispheres. Additionally, the number of amide III bonds was increased with ELF-MF exposure in the cerebellum and left-brain tissue. In liver tissue higher Raman intensities were visible in the tissues from the ELF-MF group. In this group the electromagnetic field also caused structural changes in lipids. Principal component analysis (PCA) showed, that itis possible to distinguish ELF-MF and control groups. Consequently, hierarchical component analysis (HCA) showed that tissues from ELF-MF and control groups separately created similarity with the groups. Obtained results suggest that the electromagnetic field caused structural and quantitative chemical changes in brain and liver tissue. Additionally, present data suggest that ELF-MF plays an important role in the regulation of enzyme activity and has effects on biochemical processes, possibly improved by production of ROS.
https://pubmed.ncbi.nlm.nih.gov/35189391/

THE POTENTIAL ROLE OF UV AND BLUE LIGHT FROM THE SUN, ARTIFICIAL LIGHTING, AND ELECTRONIC DEVICES IN MELANOGENESIS AND OXIDATIVE STRESS

Enrique Navarrete de Gálvez, José Aguilera, Alba Solis, María Victoria de Gálvez, José Ramón de Andrés, Enrique Herrera-Ceballos, Alfonso Gago-Calderon. J Photochem Photobiol B. 2022 Feb 4;228:112405. doi: 10.1016/j.jphotobiol.2022.112405 article

Highlights

- LED technology is being increasingly used in electronic devices and to provide both indoor and outdoor lighting.
- Normal daily dose of blue light emitted by LED devices is less than 5% compared to sun for inducing skin pigmentation.
- Long time LED overexposure as during the COVID-19 lockdown enhance risk factors for hyperpigmentation.

Abstract

Our exposure to blue light from artificial sources such as indoor lights (mainly light-emitting diodes [LEDs]) and electronic devices (e.g., smartphones, computer monitors, and television screens), has increased in recent years, particularly during the recent coronavirus disease 2019 lockdown. This radiation has been associated to skin damage across its potential in generating reactive oxygen species in both the epidermis and the dermis, skin water imbalances and of potential activating melanin production. These circumstances make it important to determine whether current blue light exposure levels under artificial illumination and electronic devices exposure can cause the previously indicated disorders as compared to solar UV and visible radiation in a typical summer day. Blue light accounted for 25% of the sun's rays, approximately 30% of radiation emitted by electronic devices, and approximately from 6% to 40% of that emitted by indoor lights. The reference equations

showed that the sun was the main source of effective irradiance for immediate and persistent pigmentation as well as for potential oxidative stress in our skin. Effective blue light exposure to artificial devices is significantly lower than the solar contribution. However, its contribution must be considered as accumulative dose effect, and especially in people with hypersensitivity promoting skin hyperpigmentation.

Conclusions

Exposure to blue light has health consequences, including photoaging and hyperpigmentation. LED technology is being increasingly used to provide both indoor and outdoor lighting and it emits a considerable proportion of blue light. The effective irradiance for PPD, IPD and oxidative stress emitted by sun and the different artificial light devices calculated for an office worker show that the contribution of sources other than the sun to the effects of PPD and IPD is less than 1% and less than 5% for the case of oxidative stress. Despite the low effective irradiance emitted by electronic devices and artificial light compared to solar radiation, that could lead to think no photo damaging effect of artificial devices, we must consider that the responses of the skin are a consequence of the integration of all daily exposure to light and all sources of radiation. Blue lights are potentially harmful to our skin in the long terms. In any case, in the absence of sunlight, artificial sources lack the potential to induce photodamage to the skin under normal use conditions, with the exception of photosensitive patients as well as high skin phototypes. These people must protect themselves when exposed to sources of blue light....

Open access paper: https://www.sciencedirect.com/science/article/pii/S1011134422000197

MAGNETOTACTIC ADVANTAGE IN STABLE SEDIMENT BY LONG-TERM OBSERVATIONS OF MAGNETOTACTIC BACTERIA IN EARTH'S FIELD, ZERO FIELD AND ALTERNATING FIELD

Xuegang Mao, Ramon Egli, Xiuming Liu, Lijuan Zhao. PLoS One. 2022 Feb 24;17(2):e0263593. doi: 10.1371/journal.pone.0263593.

Abstract

Magnetotactic bacteria (MTB) rely on magnetotaxis to effectively reach their preferred living habitats, whereas experimental investigation of magnetotactic advantage in stable sediment is currently lacking. We studied two wild type MTB (cocci and rod-shaped M. bavaricum) in sedimentary environment under exposure to geomagnetic field in the laboratory, zero field and an alternating field whose polarity was switched every 24 hours. The mean concentration of M. bavaricum dropped by ~50% during 6 months in zero field, with no clear temporal trend suggesting an extinction. Cell numbers recovered to initial values within ~1.5 months after the Earth's field was reset. Cocci displayed a larger temporal variability with no evident population changes in zero field. The alternating field experiment produced a moderate decrease of M. bavaricum concentrations and nearby extinction of cocci, confirming the active role of magnetotaxis in sediment and might point to a different magnetotactic mechanism for M. bavaricum which possibly benefited them to survive field reversals in geological periods. Our findings provide a first quantification of magnetotaxis advantage in sedimentary environment.

Open access paper:
https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0263593

POSSIBLE HEALTH EFFECTS ON THE HUMAN BRAIN BY VARIOUS GENERATIONS OF MOBILE TELECOMMUNICATION: A REVIEW BASED ESTIMATION OF 5G IMPACT

Hiie Hinrikus, Tarmo Koppel, Jaanus Lass, Hans Orru, Priit Roosipuu, Maie Bachmann. Possible health effects on the human brain by various generations of mobile telecommunication: a review based estimation of 5G impact. Int J Radiat Biol. 2022 Jan 7;1-48. doi: 10.1080/09553002.2022.2026516.

Abstract

Purpose: The deployment of new 5G NR technology has significantly raised public concerns in possible negative effects on human health by radiofrequency electromagnetic fields (RF EMF). The current review is aimed to clarify the differences between possible health effects caused by the various generations of telecommunication technology, especially discussing and projecting possible health effects by 5G. The review of experimental studies on the human brain over the last fifteen years and the discussion on physical mechanisms and factors determining the dependence of the RF EMF effects on frequency and signal structure have been performed to discover and explain the possible distinctions between health effects by different telecommunication generations.

Conclusions: The human experimental studies on RF EMF effects on the human brain by 2G, 3G and 4G at frequencies from 450 to 2500 MHz were available for analyses. The search for publications indicated no human experimental studies by 5G nor at the RF EMF frequencies higher than 2500 MHz. The results of the current review demonstrate no consistent relationship between the character of RF EMF effects and parameters of exposure by different generations (2G, 3G, 4G) of telecommunication technology. At the RF EMF frequencies lower than 10 GHz, the impact of 5G NR FR1 should have no principal differences compared to the previous generations. The radio frequencies used in 5G are even higher and the penetration depths of the fields are smaller, therefore the effect is rather lower than at previous generations. At the RF EMF frequencies higher than 10 GHz, the mechanism of the effects might differ and the impact of 5G NR FR2 becomes unpredictable. Existing knowledge about the mechanism of RF EMF effects at millimeter waves lacks sufficient experimental data and theoretical models for reliable conclusions. The insufficient knowledge about the possible health effects at millimeter waves and the lack of in vivo experimental studies on 5G NR underline an urgent need for the theoretical and experimental investigations of health effects by 5G NR, especially by 5G NR FR2. https://pubmed.ncbi.nlm.nih.gov/34995145/

MOBILE PHONE ELECTROMAGNETIC RADIATION AND THE RISK OF HEADACHE: A SYSTEMATIC REVIEW AND META-ANALYSIS

Sajjad Farashi, Saeid Bashirian, Salman Khazaei, Mojtaba Khazaei, Abdollah Farhadinasab. Int Arch Occup Environ Health. 2022 Jan 22. doi: 10.1007/s00420-022-01835-x.

Abstract

Purpose: The effects of electromagnetic fields of mobile phones on headaches have attracted researchers during the last decades. However, contradictory results have been reported so far.

Methods: In this systematic review and meta-analysis, major databases including PubMed, Scopus and Web of Science were searched using suitable search terms and PRISMA guidelines

to retrieve eligible studies for the effect of mobile phone use on headache. After the abstract and full-text screening, 33 studies were retrieved and the effect size in terms of odds ratio (OR) was extracted. Between-study heterogeneity was assessed using I2 statistic and Q test, while publication bias was evaluated by funnel plot and Egger's and Begg's tests.

Results: Among 33 eligible studies, 30 eligible studies were included in the meta-analysis. When considering all studies, the pooled effect size of OR = 1.30 (95% CI 1.21-1.39) was obtained, while the heterogeneity between studies was significant. Subgroup analyses by considering the age of participants and EMF exposure duration were performed to find the source of heterogeneity. The odds ratios when the age of participants was the variable were 1.33 (95% CI 1.14-1.53) and 1.29 (95% CI 1.20-1.37), for ages > 18 and age ≤ 18 years, respectively. When EMF exposure duration was considered, subgroup analysis obtained the pooled effect size of OR = 1.41 (95% CI 1.22-1.61) and 1.23 (95% CI 1.12-1.34), for EMF exposure duration > 100 and ≤ 100 minutes per week, respectively. The pooled effect sizes emphasized the effect of mobile phone use on headaches for all ages and exposure durations.

Conclusion: Results revealed that age and exposure duration (mainly call duration), both were the source of heterogeneity between studies. Furthermore, results showed that increasing call duration and mobile phone use in older individuals increased the risk of headache.

Conclusion

Since the mobile phone becomes an indispensable device for many people, its effects on human health have been the center of attention during past decades. The current study focused on the effect of mobile phone- emitted EMFs on headaches as a common problem between children and adults. Results showed the adverse effect of mobile phones on headaches for young and adult individuals. Results showed that increasing EMF exposure (mainly call duration) augmented such effects. Furthermore, the results of studies were more homogeneous for the older population (age > 18 years) as compared with the younger group (age ≤ 18 years). In this study, all types of headaches were considered in a unique category, while their brain mechanisms might be different. In this regard, electromagnetic radiation emitted by mobile phones may influence different types of headaches in different ways. In addition, exposure time (duration in which individuals used mobile phones) is another important factor that is relatively different between included studies in this meta-analysis. These issues might be responsible for between-study heterogeneity observed in the current study. https://pubmed.ncbi.nlm.nih.gov/35064837/

MOBILE PHONE RADIATION DEFLECTS BRAIN ENERGY HOMEOSTASIS AND PROMPTS HUMAN FOOD INGESTION

Wardzinski EK, Jauch-Chara K, Haars S, Melchert UH, Scholand-Engler HG, Oltmanns KM. Mobile Phone Radiation Deflects Brain Energy Homeostasis and Prompts Human Food Ingestion. Nutrients. 2022 Jan 14;14(2):339. doi: 10.3390/nu14020339.

Abstract

Obesity and mobile phone usage have simultaneously spread worldwide. Radio frequency-modulated electromagnetic fields (RF-EMFs) emitted by mobile phones are largely absorbed by the head of the user, influence cerebral glucose metabolism, and modulate neuronal excitability. Body weight adjustment, in turn, is one of the main brain functions as food intake

behavior and appetite perception underlie hypothalamic regulation. Against this background, we questioned if mobile phone radiation and food intake may be related. In a single-blind, sham-controlled, randomized crossover comparison, 15 normal-weight young men (23.47 ± 0.68 years) were exposed to 25 min of RF-EMFs emitted by two different mobile phone types vs. sham radiation under fasting conditions. Spontaneous food intake was assessed by an ad libitum standard buffet test and cerebral energy homeostasis was monitored by 31phosphorus-magnetic resonance spectroscopy measurements. Exposure to both mobile phones strikingly increased overall caloric intake by 22-27% compared with the sham condition. Differential analyses of macronutrient ingestion revealed that higher calorie consumption was mainly due to enhanced carbohydrate intake. Measurements of the cerebral energy content, i.e., adenosine triphosphate and phosphocreatine ratios to inorganic phosphate, displayed an increase upon mobile phone radiation. Our results identify RF-EMFs as a potential contributing factor to overeating, which underlies the obesity epidemic. Beyond that, the observed RF-EMFs-induced alterations of the brain energy homeostasis may put our data into a broader context because a balanced brain energy homeostasis is of fundamental importance for all brain functions. Potential disturbances by electromagnetic fields may therefore exert some generalized neurobiological effects, which are not yet foreseeable.

Conclusions
Our human study demonstrates that the RF-EMFs radiation emitted by mobile phones results in significantly increased food ingestion, particularly carbohydrate intake. Moreover, a deflected cerebral high-energy phosphate metabolism, which is closely related to food intake and body weight, was found after mobile phone use. Therefore, our results identify RF-EMFs as a potential contributing factor to overeating in humans, which underlies the worldwide obesity epidemic. Beyond this, RF-EMF-induced alterations of the brain energy homeostasis, as observed here, may put our data into a broader context because a balanced central nervous energy homeostasis is of fundamental importance, not only for the regulation of food intake and body weight, but also for all brain functions. Therefore, with good cause, the high priority of this research field was already emphasized a long time ago by the WHO Research Agenda for Radiofrequency Fields [65]. Perhaps our data could serve as first step towards deeper insight into this issue and open a new perspective in neurobiological and obesity research.
Open access paper: https://www.mdpi.com/2072-6643/14/2/339/htm

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EFFECTS OF RADIOFREQUENCY ELECTROMAGNETIC FIELDS (RF EMF) ON CANCER IN LABORATORY ANIMAL STUDIES (WHO SR2)

Meike Mevissen, Jerrold M. Ward, Annette Kopp-Schneider, James P. McNamee, Andrew W. Wood, Tania M. Rivero, Kristina Thayer, Kurt Straif. Effects of radiofrequency electromagnetic fields (RF EMF) on cancer in laboratory animal studies. Environment International. Volume 161, 2022. 107106. doi: 10.1016/j.envint.2022.107106.

Abstract
Background The carcinogenicity of radiofrequency electromagnetic fields (RF EMF) has been evaluated by the International Agency for Research on Cancer (IARC) in 2011. Based on limited evidence of carcinogenicity in humans and in animals, RF EMF were classified as possibly carcinogenic to humans (Group 2B). In 2018, based on a survey amongst RF experts, WHO prioritized six major topics of potential RF EMF related human health effects for systematic

reviews. In the current manuscript, we present the protocol for the systematic review of experimental laboratory animal studies (cancer bioassays) on exposure to RF fields on the outcome of cancer in laboratory animals.

Objective In the framework of WHO's Radiation Program, the aim of this work is to systematically evaluate effects of RF EMF exposure on cancer in laboratory animals.

Study eligibility and criteria WHO's Handbook (2014) for guideline development will be followed with appropriate adaptation. The selection of eligible studies will be based on Population, Exposures, Comparators, and Outcomes (PECO) criteria. We will include peer-reviewed articles and publicly available reports from government agencies reporting original data about animal cancer bioassays on exposure to RF EMF. The studies are identified by searching the following databases: MEDLINE (PubMed), Science Citation Index Expanded and Emerging Sources Citation Indes (Web of Science), Scopus, and the EMF Portal. No language or year-of- publication restrictions are applied. The methods and results of eligible studies will be presented in accordance with the PRISMA 2020 guidelines.

Study appraisal method Study evaluation of individual studies will be assessed using a risk of bias (RoB) tool developed by the Office of Health Assessment and Translation (OHAT) with appropriate considerations including sensitivity for evaluating RF EMF exposure in animal cancer bioassays. The final evaluation on the certainty of the evidence on a carcinogenic risk of RF EMF exposure in experimental animals will be performed using the OHAT Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach with appropriate considerations. The protocol has been registered in an open-source repository (PROSPERO).

Funding The study is partly financially supported by the World Health Organization. No additional funding was provided outside author salaries through their places of employment.

Declaration of Competing Interest The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: AWW directs a research group, which includes three technical associates who are telecommunications company employees. JM receives employment and research support from The government of Canada related to the topic. KS has been the Head of the IARC Monographs program until his regular retirement (11/2018). Since 10/2019, he is a member of the International Scientific Advisory Committee of the Ramazzini Institute. This involves one 3 h advisory group meeting per year. He does not receive remuneration for his advisory activity. MM is a member of the scientific advisory board of The Swiss Research Foundation for Electricity and Mobile Communication (FSM) that receives research money from commercial entities. She does not receive remuneration for his advisory activity. Her partner does consulting relating to cell phone safety. All remaining authors declare no conflict of interest.

https://www.sciencedirect.com/science/article/pii/S0160412022000320

IPHONE 12 MAGSAFE TECHNOLOGY AND CARDIAC IMPLANTABLE DEVICES: ASSESSMENT OF THE ACTUAL RISK

Federica Censi, Eugenio Mattei, Graziano Onder, Giovanni Calcagnini. iPhone 12 MagSafe technology and cardiac implantable devices: assessment of the actual risk. Pacing Clin Electrophysiol. 2022 Jan 25. doi: 10.1111/pace.14450.

Abstract

Background: Pacemaker (PM) and implantable cardioverter defibrillators (ICD) are equipped with a magnetic sensor activated by external application of magnets to easily manage some functions of these devices. If activated inadvertently or outside a controlled environment and without the supervision of clinical personnel, this magnetic mode introduces a potential risk. In reality, the possibility of a static magnetic field affecting a PM or ICD is remote. However, the presence of the magnet in the iPhone 12 made the possibility of inadvertently activating the magnetic switch of PM and ICD less remote.

Objective: This study investigates the effects of magnetic interference of the iPhone 12 on a large set of cardiac implantable devices representative of the current market and proposes adequate rules of conduct.

Methods: We investigated the risk of the magnetic interference of the iPhone 12 and its MagSafe accessories on a comprehensive set of PMs and ICDs, including the subcutaneous ICD. For the first time, the magnetic interference phenomena were correlated with the magnetic field levels measured all around iPhone 12.

Results: We discovered that the magnets inside iPhone 12 trigger the magnetic mode in the 12 tested devices up to a distance of 1 cm.

Conclusions: Considering the implications related to the activation of the magnetic switch, to date, it is advisable to follow Apple's indications relating to the safety distance of 15 cm, which is widely compatible with the results obtained from this paper and in line with the indications provided by the implantable cardiac device manufacturers.

https://pubmed.ncbi.nlm.nih.gov/35076120/

Excerpts

"Apple also found it appropriate to emphasize in the instructions for use that “Medical devices such as implanted pacemakers and defibrillators may contain sensors capable of reacting to magnets and radio frequencies when in close contact. To avoid potential interactions with these devices, keep your iPhone and MagSafe accessories at a safe distance from the device (more than 15 centimeters away, or more than 30 centimeters if wireless charging is activated). [15] Considering the implications related to the activation of the magnetic switch of cardiac implantable devices, as a rule of conduct, to date, it is advisable to follow Apple's indications relating to the safety distance of 15 cm, which are widely compatible with the results obtained from this paper and in line with the indications provided by the manufacturers of the implantable cardiac devices. However, since in real-life scenarios such distance is not always respected, it would be advisable to alert the patient about this specific iPhone 12 concern. Also, it would be important to investigate this question further for the new iPhone models, as long as they still remain MagSafe compatible."

INTERFERENCE BY MODERN SMARTPHONES AND ACCESSORIES WITH CARDIAC PACEMAKERS AND DEFIBRILLATORS

Fahd Nadeem, Cao Thach Tran, Estelle Torbey, Daniel Philbin, Carlos Morales, Michael Wu. Interference by Modern Smartphones and Accessories with Cardiac Pacemakers and Defibrillators. Curr Cardiol Rep. 2022 Jan 27. doi: 10.1007/s11886-022-01653-0.

Abstract

Purpose of review: The risk of cardiac implantable electronic device (CIED) interference from cell phones was previously thought to be low based on older studies. Current generation of smartphones have incorporated more magnets for optimization of wireless charging, attachment of accessories, and convenience functionalities. These magnets have the potential to cause CIEDs to inadvertently revert into magnet mode. The purpose of this review is to summarize recent findings on smartphones and their accessories causing interference on CIEDs.

Recent findings: Recent reports have demonstrated that the iPhone 12 series and accessories have the capability to cause CIED magnetic interference. Current generation of smartphones, smartwatches, wireless headphones, and accessories have the potential to cause CIEDs to revert into magnet mode in both in vivo and ex vivo experiments. The risk of a clinically significant event is unlikely as long as the Food and Drug Administration (FDA) recommendations are followed; keeping smartphones and accessories at least six inches away from CIEDs. https://pubmed.ncbi.nlm.nih.gov/35084671/

NUMERICAL EVALUATION OF HUMAN BODY NEAR FIELD EXPOSURE TO A VEHICULAR ANTENNA FOR MILITARY APPLICATIONS

Colella Micol, Biscarini Marianna, de Meis Marco, Patrizi Roberto, Ciallella Tino, Ferrante Daniele, De Gaetano Alessandro, Capuano Marco, Pellegrino Giovanni, Martini Emanuele, Cavagnaro Marta, Apollonio Francesca, Liberti Micaela. Numerical Evaluation of Human Body Near Field Exposure to a Vehicular Antenna for Military Applications. Frontiers in Public Health.Vol. 9. 2022. doi:10.3389/fpubh.2021.794564.

Abstract

Background The use of electromagnetic (EM) technologies for military applications is gaining increasing interest to satisfy different operational needs, such as improving battlefield communications or jamming counterpart's signals. This is achieved by the use of high-power EM waves in several frequency bands (e.g., HF, VHF, and UHF). When considering military vehicles, several antennas are present in close proximity to the crew personnel, which are thus potentially exposed to high EM fields.

Methods A typical exposure scenario was reproduced numerically to evaluate the EM exposure of the human body in the presence of an HF vehicular antenna (2–30 MHz). The antenna was modeled as a monopole connected to a 3D polygonal structure representing the vehicle. Both the EM field levels in the absence and in the presence of the human body and also the specific absorption rate (SAR) values were calculated. The presence of the operator, partially standing outside the vehicle, was simulated with the virtual human body model Duke (Virtual Population, V.3). Several exposure scenarios were considered. The presence of a protective helmet was modeled as well.

Results In the area usually occupied by the personnel, E-field intensity radiated by the antenna can reach values above the limits settled by international safety guidelines. Nevertheless, local SAR values induced inside the human body reached a maximum value of 14 mW/kg, leading to whole-body averaged and 10-g averaged SAR values well below the corresponding limits.

Conclusion A complex and realistic near-field exposure scenario of the crew of a military vehicle was simulated. The obtained E-field values radiated in the free space by a HF vehicular antenna may reach values above the safety guidelines reference levels. Such values are not necessarily meaningful for the exposed subject. Indeed, SAR and E-field values induced inside the body remain well below safety limits.
Open access paper: https://www.frontiersin.org/articles/10.3389/fpubh.2021.794564

A COHERENT FRAMEWORK FOR NON-IONISING RADIATION PROTECTION

Tinker R, Abramowicz J, Karabetsos E, Magnusson S, Matthes R, Moser M, Niu S, O'Hagan J, van Deventer E. A coherent framework for non-ionising radiation protection. J Radiol Prot. 2022 Jan 12;42(1). doi: 10.1088/1361- 6498/ac3bc3.

Abstract

A coherent and overarching framework for health protection from non-ionising radiation (NIR) does not currently exist. Instead, many governments maintain different compliance needs targeting only some NIR exposure situations. An international framework developed by the World Health Organization would promote a globally consistent approach for the protection of people from NIR. Designed based on decades of practical experience the framework provides guidance on establishing clear national health and safety objectives and how they should be achieved. It supports multisectoral action and engagement by providing a common language and systematic approach for managing NIR. The framework should allow governments to respond to policy challenges on how to achieve effective protection of people, especially in a world that is rapidly deploying new NIR technologies. In this paper the concepts and key features are presented that underpin the framework for NIR protection, including examples of implementation.
Open access paper: https://iopscience.iop.org/article/10.1088/1361-6498/ac3bc3

A MONTE CARLO ANALYSIS OF ACTUAL MAXIMUM EXPOSURE FROM A 5G MILLIMETER-WAVE BASE STATION ANTENNA FOR EMF COMPLIANCE ASSESSMENTS

Xu Bo, Anguiano Sanjurjo David, Colombi Davide, Törnevik Christer. A Monte Carlo Analysis of Actual Maximum Exposure From a 5G Millimeter-Wave Base Station Antenna for EMF Compliance Assessments. Frontiers in Public Health. Vol 9. 2022. doi:10.3389/fpubh.2021.777759.

Abstract

International radio frequency (RF) electromagnetic field (EMF) exposure assessment standards and regulatory bodies have developed methods and specified requirements to assess the actual maximum RF EMF exposure from radio base stations enabling massive multiple-input multiple-output (MIMO) and beamforming. Such techniques are based on the applications of power reduction factors (PRFs), which lead to more realistic, albeit

conservative, exposure assessments. In this study, the actual maximum EMF exposure and the corresponding PRFs are computed for a millimeter-wave radio base station array antenna. The computed incident power densities based on near-field and far-field approaches are derived using a Monte Carlo analysis. The results show that the actual maximum exposure is well below the theoretical maximum, and the PRFs similar to those applicable for massive MIMO radio base stations operating below 6 GHz are also applicable for millimeter-wave frequencies. Despite the very low power levels that currently characterize millimeter-wave radio base stations, using the far-field approach can also guarantee the conservativeness of the PRFs used to assess the actual maximum exposure close to the antenna.
Open access paper: https://www.frontiersin.org/article/10.3389/fpubh.2021.777759

RF-EMF EXPOSURE MEASUREMENT FOR 5G OVER MM-WAVE BASE STATION WITH MIMO ANTENNA

S. Q. Wali, A. Sali, J. K. Allami, A. F. Osman. RF-EMF Exposure Measurement for 5G over mm-Wave Base Station with MIMO Antenna. IEEE Access. 2022. doi: 10.1109/ACCESS.2022.3143805.

Abstract

The fifth-generation (5G) technology offers more capacity and data rates than the previous generations. It provides ultra-low latency and ultra-high dependability, allowing for efficient services in many industries. Using radiofrequency electromagnetic fields (RF-EMF) above 6 GHz in 5G millimeter Wave(mm-Wave) base stations has concerned many people due to the potential health risks caused by EMF exposure. This study aims to measure the maximum exposure emitted by a 5G mm-Wave base station by utilizing international standards in both its assessment methodology and exposure limits. In this study, the R&S®TSMA6 scanner, R&S®ROMES4 software, and R&S®TSME30DC down converter have been used for the measurement campaign; in addition to the user equipment device (UE), GPS, and an omnidirectional antenna. The investigation is based on a code selective method due to the radiated power fluctuations over time with data traffic. To conduct the measurement, six tests are taken based on three different time frames, antenna directions, and user equipment device (UE) to investigate the RF-EMF exposure. The maximum and average exposure from the 5G mm-Wave base station are calculated and compared with the ICNIRP standard. The maximum exposure from the 29.5 GHz base station is found to be 5.71 V/m, and the highest amount of average exposure is 2.02V/m. In this study, it was found that the maximum and average exposure (RF-EMF) produced from a single 5G mm-Wave base station are well within the allowed RF-EMF standard limit.

Excerpts

This section presents the methodology used in performing this work. To conduct the measurement at the base station, different scenarios and tests were chosen. Choosing a location to take the measurement was the second step. After going around the area for a few hours, the location was chosen based on getting the highest received power. The measurement was conducted in the car park of Rekascape Cyberjaya, Selangor at a 5G mm-Wave base station, the distances between the transmitter and receiver were 22 m that the highest amount of power was received. The scenario had been selected in the line of sight (LOS) location; six different tests were selected one of them was measured without connecting the UE device to the base station, while, in the other five tests, the UE device was

connected to the base station. The measurement in the LOS scenario had been taken in three different standard times to know when the maximum exposure will be recorded and to illustrate the time effect on the exposure level. Measurement was conducted at 1 minute as a default time, 6 minutes based on the ICNIRP [53]standard, and 30 minutes depending on the IEEE [54] and ICNIRP [55] standard. To analyze the Electrical field strength per channel [V/m] and Electrical field of the 5G mm-Wave base station, the data was extracted from the scanner. Then, the data was sorted in an excel sheet based on the top (n) to normal sorting where every signal synchronization block (SSB) had a fixed column to analyze the electrical field per channel in 5G base station. The maximum electric field strength (Emax) and the average electric-field strength (Avg) were analyzed. Finally, the maximum exposure and average exposure will be compared to ICNIRP [50] standard to ensure the safety of deploying 5G mm-Wave in Malaysia....

In this paper, the RF-EMF exposure for 5G over the mm-Wave base station with a MIMO antenna was investigated. From the literature, no study has been carried out analyzing the exact level of exposure from mmWave base station making it the first of its kind in Malaysia. This study investigated and elaborated on how to take the measurement, sort, extract, and calculate the data. Besides, the effect of time duration on the amount of exposure, various antenna directions, and using UE devices on six different tests was elaborated. For all the tests, the distance between the 5G mm-Wave base station (Tx) and the receiver (Rx) was the same, and the location was chosen based on getting the maximum power. It can be noticed from the data that there is a slight difference in the amount of produced exposure between the first test which is without UE, and the other tests that the UE device was connected to the BS, so the UE does not have a noticeable impact on the measurement results. The experimental results ensure that the time has a modest impact on the level of exposure, in the three-time frames. A high level of Emax from the 5G mm-Wave base station was recorded in the second, third, and fourth tests. The maximum exposure called the worst-case scenario is much higher than the average exposure emitted at the 5G mm-Wave base station. The maximum exposure at the base station among all the tests is 5.71V/m, which is recorded in video streaming from YouTube, and this value is significantly lower than the ICNIRP standard accepted limit of exposure, which is 61V/m [50]. The highest average exposure, which is 2.02V/m at the video call test, is well below the accepted RF-EMF exposure by the ICNIRP standard at the same time, it was found that the level of exposure at the mm-Wave base station is not zero. It was found that the Emax and Eavg from 5G mm-Wave selected base station in this work, are within the limits, indicating that it does not have effects on human health. Nevertheless, there is a need for further investigations on the RF- EMF exposure from 5G mm-Wave in areas that are surrounded by many mm-Wave base stations and for a longer measurement time duration.
https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9682753&isnumber=6514899

ASSESSMENT OF CORTISOL SECRETORY PATTERN IN WORKERS CHRONICALLY EXPOSED TO ELF-EMF GENERATED BY HIGH VOLTAGE TRANSMISSION LINES AND SUBSTATION

Yvan Touitou, Brahim Selmaoui, Jacques Lambrozo. Environ Int. 2022 Feb 1;161:107103. doi: 10.1016/j.envint.2022.107103

Abstract

We investigated the effects of extremely-low frequency electromagnetic fields (ELF-EMFs; 50 Hz) on the secretion of cortisol in 14 men (mean age = 38.0 ± 0.9 years) working in extra-high voltage (EHV) substations. The workers dwelt in houses that were close to substations and high-voltage lines. Thus, they had long histories (1-20 years) of long-yerm exposure to ELF-EMFs. Magnetic field strength was recorded using Emdex dosimeters worn by the volunteers day and night for seven days; the one-week geometric mean ranged from 0.1 to 2.6 µT. Blood samples were taken hourly from 20:00 to 08:00 the next morning. Cortisol concentrations and patterns were compared to age-matched, unexposed control subjects whose exposure level was ten times lower. The comparison of the control group (n = 15) and the groups exposed to fields of 0.1-0.3 µT (n = 5) and > 0.3 µT (n = 9), respectively, revealed a significant effect of field intensity on the cortisol secretory pattern. This study strongly suggests that chronic exposure to ELF-EMFs alters the peak-time serum cortisol levels. Studies are required on the effect of this disruption in high-risk populations such as children, elderly people, and patients with cancer.

Highlights

- Health risks, including cancer, are associated with exposure to electric and magnetic fields.
- Most available literature describes biological changes following short-term exposure.
- Additional effects due to long-term exposure cannot be ruled out.
- Hypothalamic-pituitary-adrenal axis and ELF-EMF relationship has been highlighted.
- We report a decline in the peak-time concentration of cortisol in workers exposed for 1 to 20 years.
- Cortisol secretion and the related biological mechanisms should be monitored in long-term exposure to ELF- EMF.

Open access paper: https://www.sciencedirect.com/science/article/pii/S0160412022000290

RECEIPT OF ELECTROCONVULSIVE THERAPY AND SUBSEQUENT DEVELOPMENT OF AMYOTROPHIC LATERAL SCLEROSIS: A COHORT STUDY

Gabor Mezei, Edmund Lau, Nelson D Pace, Jamie Schenk, Leeka Kheifets. Receipt of Electroconvulsive Therapy and Subsequent Development of Amyotrophic Lateral Sclerosis: A Cohort Study. Bioelectromagnetics. 2022 Feb;43(2):81-89. doi: 10.1002/bem.22389.

Abstract

We investigated the potential relationship between receipt of electroconvulsive therapy (ECT) and development of amyotrophic lateral sclerosis (ALS). We conducted a cohort study using a sample of more than one million beneficiaries enrolled in the U.S. Medicare health insurance program from 1997 to 2017. Using time-varying proportional hazard modeling, we compared ALS occurrence among patients diagnosed with psychiatric conditions who received ECT to ALS occurrence among patients diagnosed with psychiatric conditions but

who did not receive ECT. We observed moderately increased, but imprecise, hazard ratios (HR) for ALS following ECT (HR = 1.39, 95% confidence interval [CI]: 0.69-2.80). A statistically significant increase in the HR of ALS was observed among those who received more than 10 ECT treatments (>10 treatments, HR = 2.24, 95% CI: 1.00- 5.01), compared to those receiving no ECT, with an even stronger association observed among subjects older than 65 years (HR = 3.03, 95% CI: 1.13-8.10). No monotonic exposure-response relationship was detected in categorical analyses. Our results provide weak support for the hypothesis that receipt of ECT increases the risk of developing ALS. Additional studies in larger populations, or in populations where ECT is more common, will be needed to refute or confirm an association between receipt of ECT and subsequent development of ALS. https://pubmed.ncbi.nlm.nih.gov/35066895/

CHAIN-LIKE STRUCTURES OF BIOGENIC AND NONBIOGENIC MAGNETIC NANOPARTICLES IN VASCULAR TISSUES

Svitlana Gorobets, Oksana Gorobets, Yuri Gorobets, Maryna Bulaievska. Chain-Like Structures of Biogenic and Nonbiogenic Magnetic Nanoparticles in Vascular Tissues. Bioelectromagnetics. 2022 Feb;43(2):119-143. doi: 10.1002/bem.22390.

Abstract

In this paper, slices of organs from various organisms (animals, plants, fungi) were investigated by using atomic force microscopy and magnetic force microscopy to identify common features of localization of both biogenic and nonbiogenic magnetic nanoparticles. It was revealed that both biogenic and nonbiogenic magnetic nanoparticles are localized in the form of chains of separate nanoparticles or chains of conglomerates of nanoparticles in the walls of the capillaries of animals and the walls of the conducting tissue of plants and fungi. Both biogenic and nonbiogenic magnetic nanoparticles are embedded as a part of the transport system in multicellular organisms. In connection with this, a new idea of the function of biogenic magnetic nanoparticles is discussed, that the chains of biogenic magnetic nanoparticles and chains of conglomerates of biogenic magnetic nanoparticles represent ferrimagnetic organelles of a specific purpose. Besides, magnetic dipole-dipole interaction of biogenic magnetic nanoparticles with magnetically labeled drugs or contrast agents for magnetic resonance imaging should be considered when designing the drug delivery and other medical systems because biogenic magnetic nanoparticles in capillary walls will serve as the trapping centers for the artificial magnetic nanoparticles. The aggregates of both artificial and biogenic magnetic nanoparticles can be formed, contributing to the risk of vascular occlusion. https://pubmed.ncbi.nlm.nih.gov/35077582/

EFFECT OF THE PRENATAL ELECTROMAGNETIC FIELD EXPOSURE ON COCHLEAR NUCLEUS NEURONS AND OLIGODENDROCYTES IN RATS

Levent Tümkaya, Orhan Bas, Tolga Mercantepe, Seda Cınar, Abdulkadir Özgür, Zihni Acar Yazici. Environ Sci Pollut Res Int. 2022 Feb 3. doi: 10.1007/s11356-021-18325-1.

Abstract

Electromagnetic radiation from elecromagnetic field (EMF) sources has been an important health concern for a long time. The vast majority of this exposure is due to the widespread use of mobile phones, an important source of the EMF. The EMF generated by mobile phones may have adverse effects on the various biological structures that regulate the body system

and function. In this study, it was aimed to evaluate histopathologically the effects of 900-megahertz (MHz) EMF application in the prenatal period on the development of the ventral cochlear nucleus, which is the first place of hearing in the brainstem, at various time points of the postnatal period in rats. In the study, Sprague-Dawley pregnant rats were divided randomly into two groups as the control group and the EMF group. The rats in the EMF group were exposed to a 900-MHz EMF every day until birth, while no EMF was applied to the rats in the control group. Auditory brainstem responses of both groups were recorded on the postnatal 13th day, the day the hearing starts. Newborn rats were sacrificed by anesthesia on days 7, 10, 15, and 30. Contrary to the control group, structural damage in cochlear nuclear neurons and oligodendrocyte cell structures and increased caspase-3 activity were observed in the postnatal period in the EMF groups. However, no significant difference was observed between the groups in terms of structural damage and caspase-3 activity at different stages of the postnatal period when cochlear nucleus development was observed. According to ABS, there was no significant difference between the average latency of waves in both groups. In conclusion, this study shows that 900-MHz electromagnetic waves propagated from mobile phones during the prenatal period have no harmful effects on the development of the ventral cochlear nucleus of rats. https://pubmed.ncbi.nlm.nih.gov/35112244/

EFFECTS OF MOBILE PHONE ELECTROMAGNETIC RADIATION ON RAT HIPPOCAMPUS PROTEOME

Kumari Vandana Singh, Rakesh Arya, Jay Prakash Nirala, Debasis Sahu, Ranjan Kumar Nanda, Paulraj Rajamani. Effects of mobile phone electromagnetic radiation on rat hippocampus proteome. Environ Toxicol. 2022 Jan 5. doi: 10.1002/tox.23447.

Abstract

Worldwide, the number of mobile phone users has increased from 5.57 billion in 2011 to 6.8 billion in 2019. However, short- and long-term impact of the electromagnetic radiation emitting from mobile phones on tissue homeostasis with particular to brain proteome composition needs further investigation. In this study, we attempted a global proteome profiling study of rat hippocampus exposed to mobile phone radiation for 20 weeks (for 3 h/day for 5 days/week) to identify deregulated proteins and western blot analysis for validation. As a result, we identified 358 hippocampus proteins, of which 16 showed deregulation (log2 (exposed/sham) ≥±1.0, p-value <.05). Majority of these deregulated proteins grouped into three clusters sharing similar molecular pathways. A set of four proteins (Succinate-semialdehyde dehydrogenase: Aldh5a1, Na+ K+ transporting ATPase: Atp1b2, plasma membrane calcium transporting ATPase: PMCA and protein S100B) presenting each functional pathway were selected for validation. Western blot analysis of these proteins, in an independent sample set, corroborated the mass spectrometry findings. Aldh5a1 involve in cellular energy metabolism, both Atp1b2 and PMCA responsible for membrane transport and protein S100B have a neuroprotective role. In conclusion, we present a deregulated hippocampus proteome upon mobile phone radiation exposure, which might influence the healthy functioning of the brain. https://pubmed.ncbi.nlm.nih.gov/34984797/

Excerpts

Post 1 week of introducing animals to experimental animal house, exposure experiments were undertaken. Each animal in exposure group (n = 5) was subjected to radiofrequency signals from a set of 3G mobile phone (n = 5)

(Samsung Galaxy J2, Korea) kept on the Plexiglass cage (18.5 cm l 8.5 cm w 8.5 cm h) between 10.00 am and1.00 pm for 20 weeks (3 h/day, 5 days/week)....

The emitted 3G mobile phone radiofrequency signal used for exposure study was 1964.7 MHz. During the experimental period, the average receiving power density of mobile phones measured at different time points (W0, W6, W13, and W20) for exposure group (video calling mode), sham group (switched off mode) and control group (Open field exposure) were 0.06, 6.55 x 10 - 5, and 3.48 x 10 - 7 mW/cm2, respectively (Figure 2A). The average whole-body SAR for animals of MP-RF-EMR exposed, sham and control groups calculated at four-time points (W0, W6, W13, and W20) were 0.015, 1.34 x 10 -5, and 9.15 x 10 - 9 W/kg, respectively (Figure 2B)....

Conclusion

In this study, we report an altered hippocampus proteome in rats exposed to MP-RF-EMR for 20 weeks. We identified a set of important proteins involved in either energy metabolism (Aldh5a1, Idh3b, and ADP/ATP translocase 1), transmembrane ion pumps (Atp1b2, PMCA) or are markers of neurodegeneration or protection (S100B) in MP-RF-EMR exposed groups. At the systemic level, we did not observe stress and did not affect the brain or total body weight gain. MP-RF-EMR exposure may interfere with the nerve signaling causing hyperexcitability in neurons. For meeting energy demand and to restore neuronal resting potential, change in the hippocampal proteome might have provided an adaptive strategy. This study gives a meaningful insight into the possible effect of MP-RF-EMR on rat hippocampus proteome. Clinical significance of these findings with particular emphasis on humans needs focused studies. Elucidating the short- and long-term impact of mobile phone radiation in different biological systems is critical to generate advisory for its healthy usage.

EFFECTS OF ACUTE EXPOSURE TO 3500 MHZ (5G) RADIOFREQUENCY ELECTROMAGNETIC RADIATION ON ANXIETY-LIKE BEHAVIOR AND THE AUDITORY CORTEX IN GUINEA PIGS

Yang H, Zhang Y, Wu X, Gan P, Luo X, Zhong S, Zuo W. Effects of Acute Exposure to 3500 MHz (5G) Radiofrequency Electromagnetic Radiation on Anxiety-Like Behavior and the Auditory Cortex in Guinea Pigs. Bioelectromagnetics. 2022 Jan 23. doi: 10.1002/bem.22388.

Abstract

Numerous studies have shown that radiofrequency electromagnetic radiation (RF-EMR) may negatively affect human health. We detected the effect of 3500 MHz RF-EMR on anxiety-like behavior and the auditory cortex (ACx) in guinea pigs. Forty male guinea pigs were randomly divided into four groups and exposed to a continuous wave of 3500 MHz RF-EMF at an average specific absorption rate (SAR) of 0, 2, 4, or 10 W/kg for 72h. After exposure, malondialdehyde (MDA) levels, antioxidant enzyme activity, anxiety-like behavior, hearing thresholds, cell ultrastructure, and apoptosis were detected. Our results revealed that hearing thresholds and basic indexes of animal behavior did not change significantly after exposure ($P > 0.05$). However, the MDA levels of ACx were increased ($P < 0.05$), and catalase (CAT), superoxide dismutase (SOD), and glutathione peroxidase (GSH-px) activities were decreased ($P < 0.05$) in the exposure groups compared to the sham group. Ultrastructural changes of ACx, including swollen mitochondria and layered myelin sheaths, were observed. Cytochrome-c relocalization, caspase-9, and cleaved caspase-3 activation were detected in

the exposure groups. In conclusion, these results suggest that oxidative stress is an important mechanism underlying the biological effects of RF-EMR, which can induce ultrastructural damage to the ACx and cell apoptosis through a mitochondria-dependent mechanism. Moreover, oxidative stress, apoptosis induction and ultrastructural damage increase in a SAR-dependent manner. However, RF-EMR does not increase hearing thresholds or induce anxiety. https://pubmed.ncbi.nlm.nih.gov/35066900/

Zinc affects nuclear factor kappa b and DNA methyltransferase activity in C3H cancer fibroblast cells induced by a 2100 MHz electromagnetic field

D Duzgun Ergun, N Pastaci Ozsobaci, T Yilmaz, D Ozcelik, M T Kalkan. Zinc affects nuclear factor kappa b and DNA methyltransferase activity in C3H cancer fibroblast cells induced by a 2100 MHz electromagnetic field. Electromagn Biol Med. 2022 Jan 7;1-8. doi: 10.1080/15368378.2021.2019760.

Abstract

The use of mobile phones is becoming widespread with the development of technology, and as a result, its effects on human health are becoming more and more important every day. Studies have reported that the electromagnetic field (EMF) emitted by mobile phones may have adverse effects on the biological systems. In order to evaluate the effect of zinc (Zn) on C3H cancer fibroblast cells exposed to 2100 MHz EMF, we analyzed cell viability%, nuclear factor kappa b (NF-κB) and DNA methyltransferase (DNMT) activities. Cells were divided to following groups: Control, sham control, 2100 MHz EMF, 50 µM Zn + 2100 MHz EMF, 100 µM Zn + 2100 MHz EMF, and 200 µM Zn + 2100 MHz EMF for 2 h. We measurement cell viability, NF-κB and DNMT activities. There was increased cell viability % in the 2100 MHz EMF group compared to the control group, while the cell viability% was decreased in the 50, 100 and 200 µM Zn + 2100 MHz EMF groups compared to 2100 MHz EMF. NF-κB and DNMT activities were a significant increase in the 2100 MHz EMF group compared to the control group, although were statistically decreased in the 50, 100 and 200 µM Zn + 2100 MHz EMF groups compared to the 2100 MHz EMF group. Our results demonstrate that 2100 MHz EMF exposure in cancer fibroblast cells induce NF-κB and DNMT activities, whereas zinc supplementation reduce NF-κB and DNMT activities-induced 2100 MHz EMF. https://pubmed.ncbi.nlm.nih.gov/34994293

ACUTE AND CHRONIC EXPOSURE TO 900 MHZ RADIO FREQUENCY RADIATION ACTIVATES P38/JNK-MEDIATED MAPK PATHWAY IN RAT TESTIS

Hakan Er, Gizem Gamze Tas, Bikem Soygur, Sukru Ozen, Leyla Sati. Acute and Chronic Exposure to 900 MHz Radio Frequency Radiation Activates p38/JNK-mediated MAPK Pathway in Rat Testis. Reprod Sci. 2022 Jan 11. doi: 10.1007/s43032-022-00844-y.

Abstract

The use of electronic devices such as mobile phones has had a long stretch of rapid growth all over the world. Therefore, exposure to radio frequency radiation (RFR) has increased enormously. Here, we aimed to assess the balance between cell death and proliferation and also investigate the involvement of the JNK/p38 MAPK signaling pathway in the testis of rats exposed to 900 MHz RFR in acute and chronic periods (2 h/day, 5 days/week) for 1 or 10 weeks, respectively. The expression of proliferating cell nuclear antigen (PCNA), Bcl-xL, cleaved caspase-3, phosphorylated-JNK (p-JNK), and phosphorylated-p38 (p-p38) was analyzed in line with histopathology and TUNEL analysis in rat testis. There were no

histopathological differences between sham and RFR groups in the acute and chronic groups. PCNA expression was not altered between groups in both periods. However, alterations for cleaved caspase-3 and Bcl-xL were observed depending on the exposure period. TUNEL analysis showed a significant increase in the RFR group in the acute period, whereas no difference in the chronic groups for the apoptotic index was reported. In addition, both p-p38 and p-JNK protein expressions increased significantly in RFR groups in both periods. Our study indicated that 900 MHz RFR might result in alterations during acute period exposure for several parameters, but this can be ameliorated in the chronic period in rat testis. Here, we also report the involvement of the p38/JNK-mediated MAPK pathway after exposure to 900 MHz RFR. Hence, this information might shed light in future studies toward detailed molecular mechanisms in male reproduction and infertility.
https://pubmed.ncbi.nlm.nih.gov/35015292/

Excerpts
The carrier frequency was 900 MHz, the modulation frequency was 217 Hz, the pulse width was 0.577 ms, and the power range of the generator was 0–10 W.... During the experiment in the “signal on” situation, the measured electric field strengths over the rats’ heads positioned 3.5 cm away from the antenna were 35.5 V/m for 900 MHz The electric field background level was between 0.02 and 0.2 V/m in the shielded room. Also, the background magnetic field was measured between 0.01 and 0.03 μT...

The average whole-body SAR value at 900 MHz was 1.159 W/kg. The SAR value for the testes was on the average of 0.107 W/kg. Prior to and after all experimental sessions, the body temperatures of rats were monitored by rectal measurements. The RFR exposure did not lead to any rectal temperature raise....

A REVIEW OF THE EFFECT OF THE INTERMEDIATE FREQUENCY ELECTROMAGNETIC FIELDS ON FEMALE REPRODUCTION
Stephanie Mohammed. A Review of the Effect of the Intermediate Frequency Electromagnetic Fields on Female Reproduction. Health Phys. 2022 Jan 7. doi: 10.1097/HP.0000000000001516.

Abstract
The use of intermediate frequency (IF) fields in occupational equipment and domestic appliances is increasing dramatically. The World Health Organization consistently points out that there is a lack of scientific evidence to assess the reproductive risk in female species within the exposure limits as stated by the International Commission on Non-Ionizing Radiation Protection. The purpose of this review paper is to review the available literature on the effects of IF EMR on female reproduction in all species and to fully understand these effects. A literature review of experimental, epidemiological, in vivo, and in vitro literature from the 1800s to the present was conducted. Very few studies have been conducted on the effects of IF on female reproduction. The study of women in their workplace, laboratory rats and mice, and chicken embryos has yielded conflicting results on the dangers of IF. Some reports consider IF harmful during pregnancy, while other results show an insignificant ($p < 0.05$) correlation between the exposed group and the unexposed groups. The experiments conducted so far restrict several parameters such as field strength, frequency, and modulation to draw definitive conclusions. In two experiments, this frequency range is

considered safe for non-invasive treatment of cancerous and noncancerous ovarian cells in the initial phase. Evaluation of the IF range on reproduction should be a priority for research. This review shows that there are few reports in this field, and they all contradict each other on whether the IF field is harmful or not. Nonetheless, IF is used in medicine to treat cancer and is currently being researched for non-cancerous cells. More comprehensive IF studies should be conducted to address the limitations in these summary studies. https://pubmed.ncbi.nlm.nih.gov/34999661/

EXPOSURE OF INFANTS TO GRADIENT FIELDS IN A BABY MRI SCANNER

Fangfang Tang, Luca Giaccone, Jiahao Hao, Fabio Freschi, Tongning Wu, Stuart Crozier, Feng Liu. Exposure of Infants to Gradient Fields in a Baby MRI Scanner. Bioelectromagnetics. 2022 Jan 10. doi: 10.1002/bem.22387.

Abstract

In pediatric magnetic resonance imaging (MRI), infants are exposed to rapid, time-varying gradient magnetic fields, leading to electric fields induced in the body of infants and potential safety risks (e.g. peripheral nerve stimulation). In this numerical study, the in situ electric fields in infants induced by small-sized gradient coils for a 1.5 T MRI scanner were evaluated. The gradient coil set was specially designed for the efficient imaging of infants within a small-bore (baby) scanner. The magnetic flux density and induced electric fields by the small x, y, z gradient coils in an infant model (8-week-old with a mass of 4.3 kg) were computed using the scalar potential finite differences method. The gradient coils were driven by a 1 kHz sinusoidal waveform and also a trapezoidal waveform with a 250 μs rise time. The model was placed at different scan positions, including the head area (position I), chest area (position II), and body center (position III). It was found that the induced electric fields in most tissues exceeded the basic restrictions of the ICNIRP 2010 guidelines for both waveforms. The electric fields were similar in the region of interest for all coil types and model positions but different outside the imaging region. The y-coil induced larger electric fields compared with the x- and z- coils.
https://pubmed.ncbi.nlm.nih.gov/35005795/

THEORETICAL CONCEPTS IN MAGNETOBIOLOGY AFTER 40 YEARS OF RESEARCH

Vladimir N. Binhi, Andrei B. Rubin. Theoretical Concepts in Magnetobiology after 40 Years of Research. Cells 11, no. 2: 274. 2022. doi:10.3390/cells11020274. (This article belongs to the Special Issue Magnetic Fields and Cells)

Abstract:

This review contains information on the development of magnetic biology, one of the multidisciplinary areas of biophysics. The main historical facts are presented and the general observed properties of magnetobiological phenomena are listed. The unavoidable presence of nonspecific magnetobiological effects in the everyday life of a person and society is shown. Particular attention is paid to the formation of theoretical concepts in magnetobiology and the state of the art in this area of research. Some details are provided on the molecular mechanisms of the nonspecific action of a magnetic field on organisms. The prospects of magnetobiology for the near and distant future are discussed. Open access paper: https://www.mdpi.com/2073-4409/11/2/274/htm

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BROADBAND 75–85 MHZ RADIOFREQUENCY FIELDS DISRUPT MAGNETIC COMPASS ORIENTATION IN NIGHT-MIGRATORY SONGBIRDS CONSISTENT WITH A FLAVIN-BASED RADICAL PAIR MAGNETORECEPTOR

Leberecht, B., Kobylkov, D., Karwinkel, T. et al. Broadband 75–85 MHz radiofrequency fields disrupt magnetic compass orientation in night-migratory songbirds consistent with a flavin-based radical pair magnetoreceptor. J Comp Physiol A (2022). https://doi.org/10.1007/s00359-021-01537-8

Abstract

The light-dependent magnetic compass sense of night-migratory songbirds can be disrupted by weak radiofrequency fields. This finding supports a quantum mechanical, radical-pair-based mechanism of magnetoreception as observed for isolated cryptochrome 4, a protein found in birds' retinas. The exact identity of the magnetically sensitive radicals in cryptochrome is uncertain in vivo, but their formation seems to require a bound flavin adenine dinucleotide chromophore and a chain of four tryptophan residues within the protein.

Resulting from the hyperfine interactions of nuclear spins with the unpaired electrons, the sensitivity of the radicals to radiofrequency magnetic fields depends strongly on the number of magnetic nuclei (hydrogen and nitrogen atoms) they contain. Quantum-chemical calculations suggested that electromagnetic noise in the frequency range 75–85 MHz could give information about the identity of the radicals involved. Here, we show that broadband 75–85 MHz radiofrequency fields prevent a night-migratory songbird from using its magnetic compass in behavioural experiments. These results indicate that at least one of the components of the radical pair involved in the sensory process of avian magnetoreception must contain a substantial number of strong hyperfine interactions as would be the case if a flavin–tryptophan radical pair were the magnetic sensor.

Open access paper: https://link.springer.com/article/10.1007%252Fs00359-021-01537-8

MAGNETORECEPTION AND MAGNETIC NAVIGATION IN FISHES: A HALF CENTURY OF DISCOVERY

Naisbett-Jones LC, Lohmann KJ. Magnetoreception and magnetic navigation in fishes: a half century of discovery. J Comp Physiol A Neuroethol Sens Neural Behav Physiol. 2022 Jan 15. doi: 10.1007/s00359-021- 01527-w.

Abstract

As the largest and most diverse vertebrate group on the planet, fishes have evolved an impressive array of sensory abilities to overcome the challenges associated with navigating the aquatic realm. Among these, the ability to detect Earth's magnetic field, or magnetoreception, is phylogenetically widespread and used by fish to guide movements over a wide range of spatial scales ranging from local movements to transoceanic migrations. A proliferation of recent studies, particularly in salmonids, has revealed that fish can exploit Earth's magnetic field not only as a source of directional information for maintaining consistent headings, but also as a kind of map for determining location at sea and for returning to natal areas. Despite significant advances, much about magnetoreception in fishes remains enigmatic. How fish detect magnetic fields remains unknown and our understanding

of the evolutionary origins of vertebrate magnetoreception would benefit greatly from studies that include a wider array of fish taxa. The rich diversity of life-history characteristics that fishes exhibit, the wide variety of environments they inhabit, and their suitability for manipulative studies, make fishes promising subjects for magnetoreception studies. https://pubmed.ncbi.nlm.nih.gov/35031832/

MAGNETIC STOP SIGNS SIGNAL A EUROPEAN SONGBIRD'S ARRIVAL AT THE BREEDING SITE AFTER MIGRATION

Joe Wynn, Oliver Padget, Henrik Mouritsen, Joe Morford, Paris Jaggers, Tim Guilford. Magnetic stop signs signal a European songbird's arrival at the breeding site after migration. Science. 2022 Jan 28;375(6579):446-449. doi: 10.1126/science.abj4210.

Abstract

Although it is known that birds can return to their breeding grounds with exceptional precision, it has remained a mystery how they know when and where to stop migrating. Using nearly a century's worth of Eurasian reed warbler (Acrocephalus scirpaceus) ringing recoveries, we investigated whether fluctuations in Earth's magnetic field predict variation in the sites to which birds return. Ringing recoveries suggest that magnetic inclination is learned before departure and is subsequently used as a uni-coordinate "stop sign" when relocating the natal or breeding site. However, many locations have the same inclination angle. Data from populations with different migratory directions indicate that birds solve this ambiguity by stopping at the first place where the right inclination is encountered on an inherited return vector. https://pubmed.ncbi.nlm.nih.gov/35084979/

INVESTIGATING THE IMPACT OF WEAK GEOMAGNETIC FLUCTUATIONS ON PIGEON RACES

Petr Jandačka, Hynek Burda, Jiří Ščučka. Investigating the impact of weak geomagnetic fluctuations on pigeonraces. J Comp Physiol A Neuroethol Sens Neural Behav Physiol. 2022 Jan 28.doi: 10.1007/s00359-021-01534-x.

Abstract

The existence of avian magnetic orientation has been proved by many experimental studies, however, evidence for the use of magnetic cues by homing pigeons remains controversial. To investigate magnetic orientation by homing pigeons, we analyzed the results of pigeon races relative to weak fluctuations in the geomagnetic field, assuming that such disturbances could impact navigational efficiency if based on magnetoreception. Whereas most of the previous studies recorded and analyzed vanishing bearing of individually released pigeons, we evaluated relative duration of the homeward flight (homing speed, as a proxy of navigational efficiency) and its dependence on specific geomagnetic indices in racing pigeons released collectively. Our analysis of orientation efficiency of about 289 pigeon races over 15 years suggested slight negative correlations between geomagnetic fluctuations and homing time. Although the interpretation of this finding is manifold and not clear, it suggests that natural magnetic variations or disturbances can affect the homing orientation performance of pigeons. We suggest that studying pigeon races may have a heuristic potential and since these races are regularly and frequently organized in many countries all over the globe, examining homing performance relative to a suite of environmental variables may be useful for exploring hypotheses about pigeon navigation. https://pubmed.ncbi.nlm.nih.gov/35088124/

HEALTH SAFETY GUIDELINES AND 5G WIRELESS RADIATION [HEALTH MATTERS]

James C. Lin. Health Safety Guidelines and 5G Wireless Radiation [Health Matters]. IEEE Microwave Magazine. 23(1):10-17. Jan. 2022, doi: 10.1109/MMM.2021.3117307.

Abstract

The rollout of 5G cellular communication technology is well underway worldwide. The advocates of 5G mobile technology hail it as a faster and more secure technology than its predecessor, 3G and 4G systems. The major enabling infrastructure uses millimeter-wave (mm-wave) and phased-array technology to achieve line-of-sight directivity, high data rates, and low latency. A central vulnerability or security threat is that it may allow spying on users. Nevertheless, this is a system architecture and technology or regulatory issue but not a biological effect or health safety matter. https://ieeexplore.ieee.org/document/9632507

My note: Like several past articles written by James C. Lin in IEEE Microwave Magazine, the abstract is biased so read the paper or the following excerpts.

Excerpts

Low-band 5G starts at roughly 400 MHz and uses existing or previous 3G or 4G frequencies or newly opened frequencies to operate; the latter, for example, may overlap with the existing 4G band. The 5G rollout began with midband, which includes popular frequencies between 3 and 4 GHz. However, primary 5G technological advances are associated with high-band 5G, which promises performance bandwidth as high as 20 GHz, and multiple-input, multiple-output strategies using 64–256 antennas at short distances and offering performances up to 10 times better than the current 4G networks."

"For health safety matters, it is not apparent whether the biological responses to high-band 5G radiations would be akin to earlier generations or low-band 5G radiations, given the distinctive characteristics of mm-wave and its interaction with the complex structure and composition of pertinent, superficial biological cells and tissues such as the cornea of the eye and nerve-rich human skin, the large, protective organ of the body."

"The two most widely promulgated RF health safety guidelines or standards have recently published revisions of their respective 1998 and 2005 versions [1], [2]. The updated International Commission on Nonionizing Radiation Protection guidelines and IEEE standards appear to cater to industry wishes; they are strongly linked to thermal effects associated with measurable temperature elevations. Also, the updates seem to have been synchronized to accommodate the 5G rollout."

"To date, there has not been a single reported epidemiological study that investigated mm-waves and their potential health effects.

Thus, although there are roughly 100 published laboratory investigations of all types, and the reported biological responses are inconsistent in their association between biological effects and mm-wave exposure. Indeed, the types of reported laboratory investigations are small, limited, and diverse, considering the wide, 5G, mm-wave frequency domain. The jury on biological effects or health impacts is still out on 5G mm-waves. Moreover, there is a lack of ongoing, controlled laboratory investigations"

"If the entities responsible for safety recommendations believe what appears to be their position concerning experimental results from rats from the NIEHS/NTP that a whole-body temperature rise of 1 °C is carcinogenic, then the safety factors of 50 adopted for the public or 10 for workers would be marginal for their stated purpose and practically meaningless from the perspective of “safety” protection (more so above 6 GHz)."

"As shown in Table 1, for mm-waves, the referenced local-tissue-temperature rise in the head, torso, and limbs of humans is 5 °C. This level of temperature rise would bring the tissue temperature from a normal value of 37 °C to a hyperthermic 42 °C. A 42 °C tissue temperature is known to be cytotoxic, with exponential cell-killing capacities. It is used as the basis for clinical cancer therapy in hyperthermia treatment for cancer protocols [14]– [16]. The recently updated safety recommendations provide a reduction factor of 10 for the public’s safety and a reduction factor of two in the case of workers. In this situation, the efficacy of these updated safety recommendations is borderline, and the updated recommendations are meaningless from the perspective of safety protection.

In summary, the safety recommendation updates were based primarily on limiting the tissue-heating potentials of RF radiation to elevate body temperatures. There are significant anomalies in the recently updated safety recommendations. Moreover, aside from the aforementioned anomalies, the existing scientific data are too limited—especially at mm-wavelengths—to make a reliable assessment or conclusion with any certainty. Some of the updated safety recommendations are marginal, questionable, and lack scientific justification from the perspective of safety protection."

WIRELESS PHONE USE IN CHILDHOOD AND ADOLESCENCE AND NEUROEPITHELIAL BRAIN TUMOURS: RESULTS FROM THE INTERNATIONAL MOBI-KIDS STUDY

[My note: Conducting this type of research is a complex endeavor with a high risk of failure. Although the authors made an exemplary effort to salvage the study via supplemental substudies and post-hoc analyses, they were unsuccessful in overcoming the study's methodologic problems. Hence, in my opinion the results seem uninterpretable. See https://www.saferemr.com/2013/05/mobi-kids-childhood-brain-tumor-risk.html for background on the Mobi-Kids study.]

G. Castaño-Vinyals, S. Sadetzki, R. Vermeulen, F. Momoli, M. Kundi, F. Merletti, M. Maslanyj, C. Calderon, J. Wiart, A.-K. Lee, M. Taki, M. Sim, B. Armstrong, G. Benke, R. Schattner, H.-P. Hutter, D. Krewski, C. Mohipp, P. Ritvo, J. Spinelli, B. Lacour, T. Remen, K. Radon, T. Weinmann, E.Th. Petridou, M. Moschovi, A. Pourtsidis, K. Oikonomou, P. Kanavidis, E. Bouka, R. Dikshit, R. Nagrani, A. Chetrit, R. Bruchim, M. Maule, E. Migliore, G. Filippini, L. Miligi, S. Mattioli, N. Kojimahara, N. Yamaguchi, M. Ha, K. Choi, H. Kromhout, G. Goedhart, A. 't Mannetje, A. Eng, C.E. Langer, J. Alguacil, N. Aragonés, M. Morales-Suárez-Varela, F. Badia, A. Albert, G. Carretero, E. Cardis. Wireless phone use in childhood and adolescence and neuroepithelial brain tumours: Results from the international MOBI-Kids study. Environment International,160, 2022, 107069, doi: 10.1016/j.envint.2021.107069.

Abstract
In recent decades, the possibility that use of mobile communicating devices, particularly wireless (mobile and cordless) phones, may increase brain tumour risk, has been a concern, particularly given the considerable increase in their use by young people. MOBI-Kids, a 14-country (Australia, Austria, Canada, France, Germany, Greece, India, Israel, Italy, Japan, Korea, the Netherlands, New Zealand, Spain) case-control study, was conducted to evaluate whether wireless phone use (and particularly resulting exposure to radiofrequency (RF) and extremely low frequency (ELF) electromagnetic fields (EMF)) increases risk of brain tumours in young people. Between 2010 and 2015, the study recruited 899 people with brain tumours aged 10 to 24 years old and 1,910 controls (operated for appendicitis) matched to the cases on date of diagnosis, study region and age.

Participation rates were 72% for cases and 54% for controls. The mean ages of cases and controls were 16.5 and 16.6 years, respectively; 57% were males. The vast majority of study participants were wireless phones users, even in the youngest age group, and the study included substantial numbers of long-term (over 10 years) users: 22% overall, 51% in the 20–24-year-olds. Most tumours were of the neuroepithelial type (NBT; n = 671), mainly glioma. The odds ratios (OR) of NBT appeared to decrease with increasing time since start of use of wireless phones, cumulative number of calls and cumulative call time, particularly in the 15–19 years old age group. A decreasing trend in ORs was also observed with increasing estimated cumulative RF specific energy and ELF induced current density at the location of the tumour. Further analyses suggest that the large number of ORs below 1 in this study is unlikely to represent an unknown causal preventive effect of mobile phone exposure: they can be at least partially explained by differential recall by proxies and prodromal symptoms affecting phone use before diagnosis of the cases. We cannot rule out, however, residual confounding from sources we did not measure. Overall, our study provides no evidence of a causal association between wireless phone use and brain tumours in young people. However, the sources of bias summarised above prevent us from ruling out a small increased risk.
https://www.sciencedirect.com/science/article/pii/S0160412021006942

VERY HIGH RADIOFREQUENCY RADIATION AT SKEPPSBRON IN STOCKHOLM, SWEDEN FROM MOBILE PHONE BASE STATION ANTENNAS POSITIONED CLOSE TO PEDESTRIANS' HEADS

Tarmo Koppel, Mikko Ahonen, Michael Carlberg, Lennart Hardell. Very high radiofrequency radiation at Skeppsbron in Stockholm, Sweden from mobile phone base station antennas positioned close to pedestrians' heads. Environmental Research. Available online 4 January 2022, 112627 doi: 10.1016/j.envres.2021.112627.

Highlights

- Ambient radiofrequency radiation at Skeppsbron street, Stockholm, Sweden was measured.
- The area with highest average radiation was 12.1 V/m with maximum reading 31.6 V/m.
- Placement of mobile phone base stations at Skeppsbron represents poor radiofrequency infrastructure design yielding high exposure levels to the general public.

Abstract
In urban environment there is a constant increase of public exposure to radiofrequency electromagnetic fields from mobile phone base stations. With the placement of mobile phone base station antennas radiofrequency hotspots emerge. This study investigates an area at Skeppsbron street in Stockholm, Sweden with an aggregation of base station antennas placed at low level close to pedestrians' heads. Detailed spatial distribution measurements were performed with 1) a radiofrequency broadband analyzer and 2) a portable exposimeter.

The results display a greatly uneven distribution of the radiofrequency field with hotspots. The highest spatial average across all quadrat cells was 12.1 V $m^{-}1$ (388 mW $m^{-}2$), whereas the maximum recorded reading from the entire area was 31.6 V $m^{-}1$ (2648 mW $m^{-}2$). Exposimeter measurements show that the majority of exposure is due to mobile phone downlink bands. Most dominant are 2600 and 2100 MHz bands used by 4G and 3G mobile phone services, respectively. The average radiofrequency radiation values from the earlier studies show that the level of ambient RF radiation exposure in Stockholm is increasing. This study concluded that mobile phone base station antennas at Skeppsbron, Stockholm are examples of poor radiofrequency infrastructure design which brings upon highly elevated exposure levels to popular seaside promenade and a busy traffic street.
https://www.sciencedirect.com/science/article/pii/S0013935121019289

THE EFFECTS OF RADIOFREQUENCY EXPOSURE ON MALE FERTILITY AND ADVERSE REPRODUCTIVE OUTCOMES: A PROTOCOL FOR TWO SYSTEMATIC REVIEWS OF HUMAN OBSERVATIONAL STUDIES WITH META-ANALYSIS

Ryan P.W. Kenny, Evelyn Barron Millar, Adenike Adesanya, Catherine Richmond, Fiona Beyer, Carolina Calderon, Judith Rankin, Mireille Toledano, Maria Feychting, Mark S Pearce, Dawn Craig, Fiona Pearson. The effects of radiofrequency exposure on male fertility and adverse reproductive outcomes: A protocol for two systematic reviews of human observational studies with meta-analysis. Environment International. 158, 2022, 106968. doi: 10.1016/j.envint.2021.106968.

Abstract
Background The World Health Organization (WHO) is bringing together evidence on radiofrequency electromagnetic field (RF-EMF) exposure in relation to health outcomes, previously identified as priorities for evaluation by experts in the field, to inform exposure guidelines. A suite of systematic reviews are being undertaken by a network of topic experts and methodologists in order to collect, assess and synthesise data relevant to these guidelines. Here, we present the protocol for the systematic review on the effect of exposure to RF on adverse reproductive outcomes (human observational studies), also referred to as Systematic Review (SR) 3 within the series of systematic reviews currently being commissioned.

Objectives Following the WHO handbook for guideline development and the COSTER conduct guidelines, we will systematically review the effect of RF-EMF exposure on both male fertility (SR3A) and adverse pregnancy outcomes (SR3B) in human observational studies. Herein we adhere to the PRISMA-P reporting guidelines.

Data sources We will conduct a broad search for potentially relevant records relevant for both reviews within the following bibliographic databases: MEDLINE; Embase; and EMF Portal. We will also conduct searches of grey literature through relevant databases and organisational websites. RF-EMF experts will also be consulted. We will hand search citation and reference lists of included study records.

Study eligibility criteria We will include quantitative human observational studies on the effect of RF-EMF exposure: (in SR3A) in adult male participants on infertility, sperm morphology, concentration or total sperm count or motility; and (in SR3B) in preconception adults or pregnant women on preterm birth, small for gestational age (associated with intrauterine growth restriction), miscarriage, stillbirth and congenital anomalies.

S**tudy appraisal and synthesis methods** Titles, abstracts and then full texts will be screened in blinded duplicate against eligibility criteria with input from a third reviewer as required. Data extraction from included studies will be completed by two reviewers as will risk of bias assessment using the Office of Health Assessment and Translation (OHAT) tool. If appropriate we will undertake meta-analysis to pool effect measures and explore heterogeneity using sub-group analyses or meta-regression as feasible. We will conduct sensitivity analysis to assess the impact of any assumptions made throughout the review process. The OHAT methodology, based on the GRADE guidelines for evidence assessment, will be used to evaluate the certainty of evidence per outcome and to conclude the level of evidence of a health effect.

Conclusion This manuscript details the protocols for two systematic reviews. The aims of publishing details of both protocols are to: pre-specify their scope and methods; reduce the impact of reviewer bias; promote transparency and replicability; and improve the review process.

Prospero registration CRD42021265401 (SR3A), CRD42021266268 (SR3B).
Open access paper: https://www.sciencedirect.com/science/article/pii/S0160412021005936

THE EFFECTS OF RADIOFREQUENCY ELECTROMAGNETIC FIELDS EXPOSURE ON HUMAN SELF-REPORTED SYMPTOMS: A PROTOCOL FOR A SYSTEMATIC REVIEW OF HUMAN EXPERIMENTAL STUDIES

Xavier Bosch-Capblanch, Ekpereonne Esu, Stefan Dongus, Chioma Moses Oringanje, Hamed Jalilian, John Eyers, Gunnhild Oftedal, Martin Meremikwu, Martin Röösli. The effects of radiofrequency electromagnetic fields exposure on human self-reported symptoms: A protocol for a systematic review of human experimental studies. Environment International. 158, 2022, 106953. doi: 10.1016/j.envint.2021.106953.

Abstract

Background The technological applications of radiofrequency electromagnetic fields (RF-EMF) have been steadily increasing since the 1950s across multiple sectors exposing large proportions of the population. This fact has raised concerns related to the potential consequences to people's health. The World Health Organization (WHO) is assessing the potential health effects of exposure to RF-EMF and has carried out an international survey amongst experts, who have identified six priority topics to be further addressed through

systematic reviews, whereof the effects on symptoms is one of them. We report here the systematic review protocol of experimental studies in humans assessing the effects of RF-EMF on symptoms.

Objective Our objectives are to assess the effects of exposure to electromagnetic fields (compared to no or lower exposure levels) on symptoms in human subjects. We will also assess the accuracy of perception of presence of exposure in volunteers with and without idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF).

Eligibility criteria We will search relevant literature sources (e.g. the Web of Science, Medline, Embase, Epistemonikos) for randomized trials (comparing at least two arms) and randomised crossover trials of RF-EMF exposure that have assessed the effects on symptoms. We will also include studies that have measured the accuracy of the perception of the presence or absence of exposure. We will include studies in any language.

Study appraisal and synthesis Studies will be assessed against inclusion criteria by two independent reviewers. Data on study characteristics, participants, exposure, comparators and effects will be extracted using a specific template for this review, by two independent reviewers. Discrepancies will be solved by consensus. Risk of bias (ROB) will be assessed using the ROB Rating Tool for Human and Animal Studies and the level of confidence in the evidence of the exposure-outcome relations will be assessed using the GRADE approach. For the perception studies, we will use adapted versions of the ROB tool and GRADE assessment. Where appropriate, data will be combined using meta-analytical techniques.
Open access paper: https://www.sciencedirect.com/science/article/pii/S016041202100578X

THE EFFECT OF RADIOFREQUENCY ELECTROMAGNETIC FIELDS (RF-EMF) ON BIOMARKERS OF OXIDATIVE STRESS IN VIVO AND IN VITRO: A PROTOCOL FOR A SYSTEMATIC REVIEW

Bernd Henschenmacher, Annette Bitsch, Tonia de las Heras Gala, Henry Jay Forman, Athanassios Fragoulis, Pietro Ghezzi, Rupert Kellner, Wolfgang Koch, Jens Kuhne, Dmitrij Sachno, Gernot Schmid, Katya Tsaioun, Jos Verbeek, Robert Wright. Environment International. 158, 2022, 106932. doi: 10.1016/j.envint.2021.106932.

Abstract

Background Oxidative stress is conjectured to be related to many diseases. Furthermore, it is hypothesized that radiofrequency fields may induce oxidative stress in various cell types and thereby compromise human and animal health. This systematic review (SR) aims to summarize and evaluate the literature related to this hypothesis.

Objectives The main objective of this SR is to evaluate the associations between the exposure to radiofrequency electromagnetic fields and oxidative stress in experimental models (in vivo and in vitro).

Methods The SR framework has been developed following the guidelines established in the WHO Handbook for Guideline Development and the Handbook for Conducting a Literature-Based Health Assessment). We will include controlled in vivo and in vitro laboratory studies that assess the effects of an exposure to RF-EMF on valid markers for oxidative stress compared to no or sham exposure. The protocol is registered in PROSPERO.

We will search the following databases: PubMed, Embase, Web of Science Core Collection, Scopus, and the EMF- Portal. The reference lists of included studies and retrieved review articles will also be manually searched.

Study appraisal and synthesis method Data will be extracted according to a pre-defined set of forms developed in the DistillerSR online software and synthesized in a meta-analysis when studies are judged sufficiently similar to be combined. If a meta-analysis is not possible, we will describe the effects of the exposure in a narrative way.

Risk of bias The risk of bias will be assessed with the NTP/OHAT risk of bias rating tool for human and animal studies. We will use GRADE to assess the certainty of the conclusions (high, moderate, low, or inadequate) regarding the association between radiofrequency electromagnetic fields and oxidative stress.

Funding This work was funded by the World Health Organization (WHO). Registration The protocol was registered on the PROSPERO webpage on July 8, 2021.
Open access paper: https://www.sciencedirect.com/science/article/pii/S0160412021005572